THE EVOLUTION OF IRRIGATION IN EGYPT'S FAYOUM OASIS: STATE, VILLAGE AND CONVEYANCE LOSS

By

DAVID HAROLD PRICE

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1993

ACKNOWLEDGMENTS

I wish to thank the following people for their various contributions to the completion of this manuscript and the fieldwork on which it is based: Russ Bernard, Linda Brownell, Ronald Cohen, Lawry Gold, Magdi Haddad, Madeline Harris, Fekri Hassan, Robert Lawless, Bill Keegan, Madelyn Lockheart, Mo Madanni, Ed Malagodi, Mark Papworth, Midge Miller Price, Lisa Queen and Mustafa Suliman. A special note of thanks to my advisor Marvin Harris for his support and encouragement above and beyond the call of duty.

Funding for field research in Egypt was provided by a National Science Foundation Dissertation Research Grant (BNS-8819558).

PREFACE

> Water is important to people who do not have it, and the same is true of power. --Joan Didion

This dissertation is a study of the interaction among particular methods of irrigation and the political economy and ecology of Egypt's Fayoum region from the Neolithic period to the present. It is intended to be a contribution to the long-standing debate about the importance of irrigation as a cause and/or effect of specific forms of local, regional and national sociopolitical institutions.

I lived in the Fayoum between July 1989 and July 1990. I studied comparative irrigation activities in five villages located in subtly different ecological habitats. For the field portion of my study I relied on direct participant observation and structured interviews. The Fayoum was selected as the location for my field study because of its reliance on gravity-fed irrigation. The variety of water-lifting devices used provides a unique opportunity to examine the effects of technology on cultural evolution.

The Fayoum Oasis is a natural depression located on the far eastern edge of the Sahara Desert in Egypt's Western Desert, 70 kilometers to the southwest of Cairo (29.5 and 29.35 latitude and 30.22 and 31.5 longitude).[1] The Fayoum is the most western of the series of Libyan Oases that stretch across an area over 300 mile long. It is sometimes known as a "semi-oasis" because it receives water both from naturally occurring springs and from the Bahr Yusef Canal directly linked to the Nile River, though in a purely geological sense it is a true oasis.

The Bahr Yusef canal enters the Fayoum Depression in the east through the al-Lahun gap. It branches into hundreds of canals through its journey across the Fayoum before its waters dump into the great salt water lake known today as Birket Qarun. At the city of al-Fayoum, Bahr Yusef branches into eight major branches, supplying water to the western, northern and southern reaches of the depression. The declining contour of the Fayoum allows this distant transport of water without the aid of water-lifting devices.

In the winter and spring months there are small (often hidden) pockets of green and even water along the barren desert beyond Lake Qarun. During Ptolemaic times the winter and spring rains were collected and used by settlers living in the desert, and in modern times some villagers have farmed the small gully patches of desert that blossom with what little run-off is to be found.

The modern climate is for the most part hot, though the winter months do have cool and even cold temperatures. The mean daytime temperature for the month of September is 28.3 degrees centigrade and 11.9 degrees centigrade for the month of January (el-Quosy & el-Guindi 1981:7). This moderate climate allows for year round agriculture. The Fayoum receives less than 20 mm of rainfall each year, most of this usually falling during only five to ten days in the winter and spring time.

The surrounding desert is host to a diversity of flora and fauna. The desert fox, jackal, ostrich (Goodman et al. 1984) and cobra are still to be found in the desert, miles in from the Fayoum. During the winter months, large flocks of birds migrate through the region. Many of these stop along the marshy shores of Lake Qarun where ample supplies of shallow-water fish can be found. Storks, pelicans, herons and geese from Europe migrate through the Fayoum today just as they have for thousands of years.

The ecological setting of the Fayoum is important because the agricultural success of the Fayoum has always hinged upon the coupling of two naturally occurring ecological features: the declivity of landforms from east to west and the presence of a water source flowing into the depression at a high point where its flow could be diverted or regulated. As will be shown below, different cultures in different eras have manipulated these two features with varying degrees of return. Even the simplest modifications of canals to improve water delivery (in terms of energy expenditures and returns) have produced bountiful results.

The most significant change in the Fayoum's irrigation technology during the last thousand years has been the maintenance of constant levels of water in the Ibrahimia and Bahr Yusef canals though the construction of the Aswan High Dam. Prior to this, all users of irrigation systems were not guaranteed anything approaching an equal share of water. The volume of water that irrigators received was subject to uncontrollable factors: the rise and fall of the Nile, unpredictable dry and wet seasons and the location of their plot from the water source.

The philological origins of the name "Fayoum" are not fully understood though it seems to be derived from the Coptic word "phiom," meaning: the lake (Kees 1961:215). The Fayoum has been known by different names during different times. In Dynastic times it was known as Neferet Baht, in Ptolemaic and Roman times as Arsiniote (after Arsinoe I, the sister-wife of Ptolemy II Philadelpius).

The lush green of contemporary Fayoum is striking when compared with the harsh desert surrounding it on all sides--except for the thin green line along the Yusef canal as it enters the depression from the Nile Valley. The fertile state of the Fayoum is both ancient (culturally speaking) and modern (geologically speaking).

The beauty and fertility of the Fayoum has been a relatively constant feature for thousands of years. Two thousand years ago Strabo compared the Fayoum to the whole of Egypt and concluded that the Fayoum as a region was

> the most noteworthy of all in respect to its appearance, its fertility, and its material

> development, for it alone is planted with olive trees that are large and full grown and bear fine fruit. . . .And it produces wine in no small quantity, as well as grain, pulse,[2] and other seed-plants in very great varieties. (Strabo 1932:97)[3]

It was irrigation that transformed the Fayoum into such a garden surrounded by desert.

In any society, the adoption of irrigation makes new levels of agricultural subsistence and/or commodity production possible. Irrigation agriculture transforms the production and social organization of any society that comes to rely on its waters. The specific transformations that occur are, however, not the same for every society. The type of social formation is specifically dependent on the type of irrigation that is adopted. Some irrigation-based societies depend on small scale irrigation networks that are managed and maintained at local levels. There are also modern-industrial societies (such as the U.S.A.) that rely on massive irrigation agricultural systems, yet it would be farfetched to characterize these as "irrigation societies" or "hydraulic societies" given the overall industrial character of their mode of production.

While the contemporary Egyptian economy is not solely reliant on agricultural production, the life and economic subsistence of rural Egyptians certainly is. Over 70% of Egyptian households derive some portion of their livelihood and subsistence from agricultural pursuits. It is this nationwide reliance on hydraulic agriculture that makes irrigation of central concern to anyone wishing to understand the contemporary Egyptian state.

Development of irrigation agriculture has the potential to dramatically increase agricultural production, beyond what is possible with simple rain-fed agriculture. Irrigation's ability to improve agricultural returns has made it a central element in theories of pristine state formation as well as a favorite method of supposedly "aiding" nations of the developing world out of their sinking debtor status.[4]

In the Egyptian ecological setting, irrigation water is the single most significant variable in crop production and the limited availability of water determines the nature and extent of current agricultural practices. Given enough water Egypt could put millions of hectares of desert wastelands into crop production.[5] If more water were available, then different and more valuable crops could be planted even in the regions currently under cultivation. Vast regions of the Western and Eastern Deserts could become as productive as the present Nile Valley and Delta (of course, the problems of drainage and salinization would increase at proportionate rates too). If water were an unlimited resource, farmers could select water intensive and highly profitable crops such as citrus and other orchard crops. With unlimited water the populations of the Nile and Delta would spread into the present desert interior.

Water's minimal availability in a desert environment such as the Fayoum heightens its prominence as a limiting feature. Irrigation provides for greater levels of production, but presents opportunities for population growth. Increased population levels can be supported after artificial irrigation is introduced in an environment, and improvements in water delivery technologies can lead to increases in productivity and population levels. As we will see, the processes of cultural evolution can be propelled and/or constrained by the availability of irrigation water.

Geographically, the bulk of Egypt's landmass is a barren desert. Only those lands directly adjacent to the Nile or with canals connected to the Nile receive enough water to allow agriculture. The amount of available water is the variable that has determined both which land areas are habitable and to what extent the habitable lands can be exploited.[6] Past and present Egyptian administrations have gone to great lengths to establish political links between upriver countries whose control over the flow of the Nile threatens Egypt's existence (Waterbury 1979). Water availability is such a vital aspect of Egyptian life that the modern political state has not hesitated to declare any actions taken by nations upriver that lead to a reduction of the Nile's flow as acts of war.

The irrigation system of the Fayoum provides an excellent opportunity to study the role of the state in irrigation activities of smallholding farmers and to see if the material infrastructural parameters of the gravity-fed water delivery system constrain and shape the formation of the social structure. My interest in the functional role of the Egyptian state comes from the classic arguments over the role of the centralized state in the formation and management of irrigation in antiquity and the present.

Three principal problems relating to the supply and management of water have faced each administration in Egypt during the past 5,000 years: digging and maintaining canals; lifting water; and draining water to prevent salinization.

Although historically the problems of drainage, canal construction and maintenance are found all along the Nile Valley and the Delta's annual flood regions, they have always been especially acute in the Fayoum because of the prevalence of perennial irrigation in this region. A commitment to perennial irrigation requires extra levels of year-round diligence with special attention to the problems of drainage.

Any culture dependent on irrigation agriculture faces problems of building and maintaining irrigation works, whether these works are simple unlined ditches, massive concrete channels or steel water pipes. Canal construction and maintenance is slow work, requiring a labor force and some form of managerial coordination and engineering. All irrigation systems also require cleaning and reconstruction on a regular basis.

Different regions in Egypt have dealt with the water lifting problem in different ways. Historically, in the Nile Valley and Delta regions, the seasonal increases in the Nile's flow have been sufficient for raising water to the level of farmers' fields. Since the construction of the High Dam at Aswan, almost all of Egypt's water lifting is now accomplished through mechanical means.

The third problem, drainage, is the inevitable consequence of solving the first two problems. Neglecting drainage can more easily destroy the workings of an irrigation system than any other factor. If lands are destroyed by salinization, it matters little if adequate waters reach a field. Salinization occurs when irrigation water left standing on fields percolates salts to the soil's surface. The hot Egyptian climate also increases salinization through the processes of rapid evaporation. The dangers of salinization increase with year-round irrigation because more water is spending more time on the soil surface.

Coping with each of these problems creates a number of social and political relationships. Different circumstances (demographic, ecological, technological, economic) select for different strategies, while different strategies produce different forms of social organization. In effect it is these sorts of managerial problems that give birth to particular forms of social organization.

All components of infrastructure (Harris 1968; Harris 1978; Sanderson 1990) directly influence Egyptian hydrology. The technological, economic, environmental and demographic conditions have everything to do with the success in digging and maintaining of canals, lifting water and draining water. As we will see, the Fayoum's hydraulic history documents the success of various administrations by the degree to which they adapted their administration to the specific requirement of the Fayoum's particular environment.

As we will see, the various state administrations that have governed the Fayoum from Dynastic times to the present have used different technologies (with varying results) to harness the hydraulic potential of the Fayoum. These different administrations have functioned under varying degrees of centralized and decentralized control (both weak and strong), and in the Fayoum, the degree to which an administration was centralized determined the region's agricultural productiveness.

Notes

1. The Western Desert is also known in the literature as the Libyan Desert.

2. Pulse refers to the edible seeds of a wide variety of pod bearing, pea and bean plants. From the latin word puls.

3. Writing as a Roman colonialist Strabo could not resist the temptation to complain about the perceived short comings of the local population. Following his descriptions of the bountiful land he continues on to say that no doubt the trees would produce "good olive oil if the olives were

carefully gathered. But since they neglect this matter, although they make much oil, it has a bad smell" (Strabo 1932:97).

4. Ironically it was through this very "aiding" process that most client nations became debtors in the fist place (Hancock 1989).

5. The technological means of transporting water to desert regions also limits the areas of agriculture in Egypt.

6. A discussion of the implications of Mehanna et al's (1984) erroneous assumption that irrigation in the Fayoum is limited by time and not water is included in chapter five.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THE EVOLUTION OF IRRIGATION IN EGYPT'S FAYOUM OASIS:
STATE, VILLAGE AND CONVEYANCE LOSS

By

David Harold Price

August 1993

Chairman: Marvin Harris
Major Department: Anthropology

Ethnographic and historical materials are used to examine relationships among various centralized and decentralized state administrations and irrigation projects in Egypt's Fayoum Oasis. The localized organization of irrigation activities outside the control of the state is also examined.

A general review of Wittfogel's theory of hydraulic societies highlights Wittfogel's often ignored distinction between "hydraulic" and "hydroagricultural" societies. Many of the past criticisms of Wittfogel's theory must now be reexamined due to their failure to address this distinction. The cross-cultural evidence for hydraulic conveyance loss is also discussed, and a generalized cross-cultural pattern favoring up-canal irrigators is postulated.

The historical analysis demonstrates how the various state administrations that governed the Fayoum from Dynastic times to the present have used different technologies (with varying results) to harness the hydraulic potential of the Fayoum. These administrations functioned under varying degrees of centralized and decentralized control (both weak and strong). It is argued that the degree to which an administration was centralized determined the Fayoum's agricultural productiveness.

The current local and state organization of contemporary irrigation practices is compared, and the Fayoum's current dependence on the supra-local coordination of irrigation activities is stressed. Water theft and irrigators' perceptions of power within local irrigation networks are shown to be indirect products of the forces of conveyance loss.

PART ONE

THEORETICAL MODELS AND HISTORICAL INSTANCES

CHAPTER 1
WITTFOGEL AND THEORIES OF THE HYDRAULIC STATE

> If irrigation farming depends on the effective handling of a major supply of water, the distinctive quality of water--its tendency to gather in bulk--becomes institutionally decisive. A large quantity of water can be channeled and kept within bounds only by the use of mass labor; and this mass labor must be coordinated, disciplined, and led. ---Karl Wittfogel 1957:18

This chapter examines cultural evolutionary theories of hydrology. The theory of the Asiatic mode of production as it relates to the roots of Karl Wittfogel's theory of hydraulic states is critically reviewed. Wittfogel's often overlooked distinction between hydraulic and hydroagricultural societies is examined with particular reference to anthropological critiques of Wittfogel's theories. Differences between hydraulic and hydroagricultural societies are examined because Wittfogel's critics have unfairly dismissed much of his theory by not addressing this distinction.[1] The cross-cultural effects of conveyance loss on social formations are later examined as an important but often overlooked aspect of the cultural evolution of irrigation societies.

Irrigation and the Asiatic Mode of Production

Inevitably, any anthropological discussion of the evolution of irrigation systems must address the writings of Engels, Marx and Wittfogel on the Asiatic mode of production. Issues of irrigation and power have played an important role in the development of materialist cross-cultural theory building since Marx and Engels first recognized that the irrigation-based economies of Asia had evolved differently from those of the feudal and capitalist West. In the late 1950s and 1960s Karl Wittfogel's "hydraulic" theory strongly influenced anthropological theories of state formation. Though Wittfogel's theory of the hydraulic state and "Oriental despotism" were partly derivative from Marx and Engels' writings, Wittfogel's theories must be seen as having distinct epistemological and political roots.

Marx and Engels State the Problem

Marx and Engels' wrote volumes on the evolution of western capitalism and the socialist/communist forms of production they believed would follow. Any specific analysis of noncapitalist modes of production was minimal, and even Engels' Origin of the Family, Private Property and the State (1884) only really addresses the evolution of western society (see Leacock's comments 1972:49).

Marx and Engels did occasionally refer to precapitalist as well as noncapitalist formations. The most famous of these is (what has become known as) the Asiatic mode of production. The idea that Asia had undergone a different path of development was of course old in the West. Montesquieu, Bodin, Bacon, Machiavelli, Hegel and others had written of the despotic empires of the East (see P. Anderson 1974:462-549; Krader 1975). The East was of interest to Marx and Engels because the East had taken a different, nonfeudal, path that had not led toward capitalism and thus needed to be accounted for. The loss of little more than a few lines and paragraphs of Marx's published works and correspondences would have eliminated all the modern Marxist debate over what the Asiatic Mode of Production is and is not.[2] This is a topic that has perhaps caused more factionalization per word than any other in the history of Marxist thought.

The Asiatic Mode of Production was almost an afterthought and clearly was a topic of little interest to Engels (who outlived Marx by 12 years and published little on the topic after Marx's death).[3] Marx and Engels characterized Asiatic society as being organized by religious institutions and having a lack of private property. They were especially intrigued by what they saw as the prevalence of communal property holdings. As Draper (1977:539) points out, Marx even went so far as to write that Asiatic modes of production were "progressive epochs in the economic formation of society."

It was Engels who first observed (in a letter to Marx) that the Orient had taken a different evolutionary path from Europe (Engels 1853). A discussion between Marx and Engels ensued on the meaning of these differences and on questions of why the East and West had divergent evolutionary developments. Marx first mentioned the Asiatic mode of production in an article on British foreign rule in India written for the New York Daily Tribune (Marx 1853a). In this article he recognized the foundation of "Asiatic despotism" in the formation of large centralized governments. This point was addressed by way of underscoring how the British administration in India was bolstering the departments of finance and war at the expense of public works which had fallen into a state of neglect.

Though Marx initially interpreted structural features as having primacy in the development of the Asiatic mode of production, he later vacillated on this and other issues relating to Asiatic formations.[4] In his initial formulation, Marx supposed the Asiatic formation was due to the peculiarities of Islamic ideology (Marx 1853a). Next he was convinced by Engels that centralized irrigation had been responsible (Abrahamian 1974 & 1975; Anderson 1974:482-483; Krader 1975:86).

It was Engels who unmuddled Marx's confusion of "agricultural relations of production" with the "forces of production." Engels favored a strictly geographical, climatological and technological (irrigation technology) basis for these societies, while Marx favored a combination of ecological and social factors. Engels believed that the lack of private property and feudal relations of production in the East was the result of a different climate and "relations to the earth," which necessitated the development of large public works for agricultural intensification (Engels 1853; Krader 1975:87).

Wrote Engels,

> But how does it come about that the Orientals did not come to property in land, not even in the feudal? I believe it lies chiefly in the climate, connected to the relations of the earth, especially to the great stretches of desert which reach from the Sahara across Arabia, Persia, India, and Tartary, right into the Asian highland. Artificial irrigation is here the first condition of agriculture, and this is a matter either of the communes, provinces, or of the central government. (Engels 1853:259)

Replied Marx,

> "Climate and territorial conditions, especially the vast tracts of desert, extending from the Sahara, through Arabia, Persia, India and Tartary, to the most elevated Asiatic highlands, constituted artificial irrigation canals and waterworks the basis of Oriental agriculture. . . .This prime necessity of an economical and common use of water, which in the Occident, drove private enterprise to voluntary association, as in Flanders and Italy, necessitated in the Orient where civilization was too low and the territorial extent too vast to call into life voluntary association, the interference of the centralizing power of Government. Hence an economical function devolved upon all Asiatic Governments, the function of providing public works. <u>This artificial fertilization of the soil, dependent on a Central Government, and immediately decaying with the neglect of irrigation and drainage, explains the otherwise strange fact that wenow find whole territories barren and desert that were once brilliantly cultivated</u>." (Marx 1853a:489-490, emphasis added).

Engels' final views on the formation of the Asiatic state are to be found in <u>Anti-Durhing</u> (1878), in which he maintained his initial position of favoring infrastructural over structural variables in the formation of the Asiatic mode of production. In disputing Duhring's claims that "force" (rather than economics or class conflict) was the catalyst of history, Engels makes explicit his belief that "all political power is originally based on an economic, social function" (Engels 1954:253).

> However great the number of despotisms which rose and fell in Persia and India each was fully aware that above all it was the entrepreneur responsible for the collective maintenance of irrigation through the river valleys without which no agriculture was possible there. It was reserved for the enlightened English to lose sight of this in India; they let the irrigation canals sluices fall into decay, and are now at last discovering through the regularly recurring famines that they have neglected one actually which might have made their rule in India at least as legitimate as that of their predecessors. (Engels 1954:249 Orig. 1894)

There is no general agreement on why Marx and Engels never fully developed their theory of the Asiatic mode of production beyond a few scattered references. As Maurice Godelier writes, "Neither Marx nor Engels abandoned their former [Asiatic] hypothesis after reading Morgan"; instead they devoted their attentions to "one of two possible forms of transition to the State" (Godelier 1978:210). However, Wittfogel (as discussed below) believed this was done to skirt the implications that a socialist/communist state with a dictatorship of the proletariate would have comparable levels of despotism. Hal Draper is correct in concluding that Marx's and Engels's lack of real concern with Asia was due to their over riding concern with accounting for the capitalist system directly in front of them, not with developing a massive evolutionary scheme for all of history and prehistory (Draper 1977:658).

After the formulation of the existence of an Asiatic mode of production by Engels and Marx, discussions of its essence became an important element of anthropological and Marxist multilineal evolutionary theories, as well as a political liability to Marxists of the Russian commune movement.[5] Within Marxism, Plekhanov and Lenin argued opposing views on whether or not Russia was a semi-Asiatic society in a debate that was always more political than empirical.

In the years following the deaths of Marx and Engels, some Marxist theorists investigated the role of infrastructure and structure in Asiatic societies as well as the role of the Asiatic mode of production in unilinear and multilinear evolutionary schema. For the most part political expediency (rather than a sense of philosophical inquiry) governed the outcomes of these debates. These questions had ethical and political dimensions.

Ethically, Marxists were left to sort out the inevitable implications that western societies--by virtue of having evolved the requisite precommunist (i.e., feudal, capitalist) modes of production--were uniquely superior to the evolutionarily dead-end (regressive) paths of the East. Politically, Marxists were faced with explaining how the

Soviet state functionally differed from its highly centralized "Asiatic" forerunners.

In large part as a reaction to the early writings of (then communist) Wittfogel, Kokin, Papaian and others, the Leningrad conference of February 1931 rejected multilinear evolutionary models and lumped Asiatic systems together with the feudal systems of the West, claiming,

> The Orient, in a very unique way, nevertheless passed through the same stages as did Europe. If many of our comrades have been unable to recognize the existence of feudalism in the Orient to this day, this is the result either of the Trotskyist fog that obscures their vision, or of a simple failure to understand the essential nature of feudalism. (Ulmen 1978:139).

As Wittfogel's biographer notes, "Then came the ultimate solution," a pronouncement by the party that "a theory that ceases to serve the revolution, that is sterile when applied to the present, must be cast aside" (Ulmen 1978:139).

Wittfogel later argued that this stance was adopted so the Soviet politicians controlling the means of production--who had outlawed the ownership of private property--could distance themselves from their Tzarist predecessors. Soviet apologists in the West found themselves in a position of dismissing or defending totalitarian actions of the Soviet state. Some attempted such a defense through denial, assuming that the reports of Stalinistic repression were simply more Western propaganda. Others saw Stalinism as a necessary evil, while, still others became disillusioned with any sort of promise of a Socialistic utopia.

Karl Wittfogel

Karl Wittfogel was a sinologist by training; his earliest works (such as Awakening China) were Marxist analyses of communist/political developments in China. With time, the central role played by irrigation in the formation of the Asiatic mode of production became his primary concern.

Wittfogel expanded upon Marx's and Engels's scant writings on the subject of the Asiatic Mode of Production to account for the formation of pristine and secondary nonfeudal despotic states throughout the world. Unfortunately, Wittfogel's later writings are so mired in his personal anticommunist crusade that it is hard to disentangle the personal antitotalitarian vehemence from his theoretical contributions. But untangling Wittfogel's valid contributions to anthropological theory is my present concern.

Wittfogel's writings covered many aspects of social evolution, but his most famous and his most misunderstood body of work involved the evolution of the "despotic" hydraulic state. I say most misunderstood because his critics ignore his distinction between hydraulic and hydroagricultural societies.

For an understanding of the evolution of the Egyptian Fayoum's irrigation system, it is important to untangle the confusion surrounding the hydraulic/hydroagricultural distinction. The failure of past scholars to differentiate between these two systems has been central to the widespread rejection of Wittfogel's work. I would go so far as to argue that the failure of Wittfogel's critics to make the distinction between hydraulic and hydroagricultural societies disqualifies many of the critiques of his hydraulic state theory. Likewise, Wittfogel's own failure to consistently maintain this distinction muddled a number of his own analyses.

The Development of Wittfogel's Theories

Wittfogel's critics generally represent his theoretical position as static and unchanging. The truth is, however, that Wittfogel's view of hydraulic societies changed throughout the years preceding and following the publication of Oriental Despotism. Many aspects of his theory remained constant, but some important details and terminological distinctions changed through time.

In his 1929 essay "Geopolitik, Geographischer Materialismus und Marxismus,"[6] Wittfogel separated irrigation societies into three categories: the Egyptian type, the Japanese type, and the Indian type (Wittfogel 1985:56-57). The distinguishing attributes of this typology were both ecological and social. His major premise was that ecological, geographical, technological and hydraulic conditions are present in irrigation societies that either do or do not allow for the development of "centralized waterworks." If conditions favoring centralized irrigation exist, then both the mechanical and social features of such a system will develop. If conditions exist that favor decentralized irrigation, then the Japanese and Indian Type decentralized irrigation societies will develop.

In the 1929 typology, the Egyptian type was the classic hydraulic state with a political/religious centralized power base. Besides Egypt, Wittfogel recognized Ancient Babylon and Imperial China as fitting the Egyptian typology. The state was seen as the dominant coordinating force necessary for the organization involved in the construction and maintenance of huge canals, dikes, dams and other waterworks. Wittfogel never claimed that the social structure of each of these societies was identical, only that they shared many of the same administrative concerns, and produced similar hierarchical structures.

The historic and prehistoric development of the world's pristine states along the banks of arid and semi arid rivers suggested to Wittfogel the presence of similar causes and effects. Wittfogel saw a pattern in the evolution of these riverine states wherein each developed centralized, despotic governments to cope with the managerial necessities of massive hydraulic enterprises (Wittfogel 1957). Wittfogel postulated that strong, centralized states evolved in riverine environments because the coordinated intensification of irrigation agriculture allowed higher levels of agricultural returns and expansion that were not possible without such centralized control.[7]

The crucial condition favoring the development of centralized irrigation systems was the presence of a riverine floodplain environment that was ecologically circumscript, yet provided an ample supply of irrigation water on an annual basis.

> It is the dissimilar structure of the naturally-conditioned powers of production within the irrigation areas, of the prerequisites of size allowing for irrigation to promote unified integration, that brings about large-scale stratification of large-scale forms of agricultural labor as well as large-scale forms of agricultural life. (Wittfogel 1985:56)[8]

The Japanese type was a nonintensifiable system characterized by geographically isolated production centers without a political/religious centralized power base. The imposition of a centralized state responsible for coordinating and intensifying agriculture would not have led to an increased productivity because of the high degree of geographic isolation and limited hydraulic resources. As Wittfogel put it,

> The Japanese Type lacks "extensive spatial sphere" of irrigation and drainage construction; the river areas could be handled locally. Thus one finds many isolated centers of production with military superstructures, many classical examples of military-feudal forms. (Wittfogel 1985:56)

Finally, the Indian type is typologically somewhere between the Egyptian and Japanese types. The Indian type has decentralized irrigation networks that function independently, yet occasionally rely on a unified moderate to large-scale labor force to construct and maintain irrigation infrastructure. Periodic demands are also made upon villages by supra-local authorities, though there are no permanent mechanisms or institutions for these activities at the village level. Though these systems are "fragmented, they simultaneously exhibit the large tasks of waterworks as well as all conceivable military feudal tasks" (Wittfogel 1985:57).

Hydraulic Versus Hydroagricultural Systems

In Oriental Despotism (published twenty-eight years later), Wittfogel dropped the typological nomenclature of "Egyptian," "Japanese" and "Indian" and instead adopted the terms hydraulic and hydroagriculture (1957:18;197). This distinction is important if we are to correctly evaluate Wittfogel's theories of state formation. Wittfogel's distinction between hydraulic and hydroagricultural societies accounts for the formation of societies that are rooted in irrigation agriculture but lack a despotic form of centralized government.

> Too little or too much water does not necessarily lead to governmental water control; nor does governmental water control necessarily imply despotic methods of statecraft. It is only above the level of an extractive subsistence economy, beyond the influence of strong centers of rainfall agriculture, and below the level of a property-based industrial civilization that man, reacting specifically to the water-deficient landscape, moves toward a specific hydraulic order of life. (Wittfogel 1957:14)[9]

The worst caricatures of Wittfogel's theory represent his argument as one in which all irrigation systems lead to a system of centralized decision-making. Nothing could be further from the truth. His definition of hydroagricultural societies clearly precludes such misunderstandings:

> Hydroagriculture, farming based on small scale irrigation, increases the food supply, but it does not involve the patterns of organization and social control that characterize hydraulic agriculture and Oriental Despotism. (Wittfogel 1957:18)

The question of how Wittfogel applied the distinction between hydraulic and hydroagriculture is a different matter altogether. There are instances where Wittfogel obviously misclassified hydroagricultural societies as hydraulic societies. It appears that Bali and Sri Lanka are two examples of hydroagricultural societies that Wittfogel misclassified as hydraulic. Edmund Leach correctly argued with Wittfogel that in Ceylon (modern Sri Lanka) there was "no evidence that the ancient central state authorities ever concerned themselves with the details of village tank management" (Leach 1959:9). Unlike hydraulic infrastructure, the irrigation system of Sri Lanka is not expandable beyond the local-community. While Leach was correct to argue the points of Wittfogel's misclassification, he was premature in disposing of the hydraulic model in general.

> While it is true that permanent agriculture is impossible without irrigation engineering, and while major government controlled irrigation works undoubtedly improve the efficiency of agriculture, it

> cannot be maintained that large scale administrative action [in Sri Lanka] is essential for the working of the system. (Leach 1959:8)

Later, I will further discuss Wittfogel's misclassification of Bali and Sri Lanka as hydraulic states.

Hydroagriculture: Preindustrial Japan

For Wittfogel the classic example of a hydroagricultural society was preindustrial Japan. Throughout the feudal age Japan's countryside was inhabited by farmers working irrigated land who were only marginally "captured" by anything representing despotic control. But for Wittfogel "traditional Japan was more than Western feudalism with wet-feet" (Wittfogel 1957:116). Irrigation was managed locally by lords who took a share of harvests, but there was nothing resembling a centralized state run economy.[10] The reasons for the evolution of this formation were clear in Wittfogel's model:

> Why did Japan's rice economy not depend on large and government-directed water works? Any competent economic geographer can answer this question. The peculiarities of the country's water supply neither necessitated nor favored substantial government-directed works. Innumerable mountain ranges compartmentalized the great Far Eastern islands; and their broken relief encouraged a fragmented (hydroagricultural) rather than a coordinated (hydraulic) pattern of irrigation farming and flood control. . . .Japan's irrigation agriculture was managed by local rather than by regional or national leaders; and hydraulic trends were conspicuous only on a local scale and during the first phase of the country's documented history. (Wittfogel 1957:197)

It was not that the rulers of preindustrial Japan did not try to install centralized hydraulic governments, it is simply that these efforts were all doomed to failure. The proliferation of rural "castle towns" at the height of the Tokugawa Shoganate (1603-1868) illustrates the limits of power faced by any potential centralized administration wishing to control vast regions of the countryside. The 250 fiefs of the late Tokugawa were separate, small, self-contained regional bureaucracies that demanded taxes and provided little in the way of services:

> Each was a more or less extensive territory held by a lord (daimyo) who lived in a castle town surrounded by armed retainers through whom he administered his lands. The administration consisted essentially of two echelons of officials: those who manned the central bureaus located in the castle or nearby in the town, and the district magistrates who were scattered about the fief. . . .What made possible this extraordinary economy of force and officialdom was the competence and reliability of local government. Nowhere, for instance did the lord undertake to levy taxes on individual peasants; rather, he laid taxes on villages as units, leaving each to allocate and collect its own, and to make up any deficit that might occur in the payment of individual families. This was but one of many administrative functions performed by villages in all parts of the country. Villages maintained their own roads and irrigation works, policed their territories, administered common land and irrigation rights. (T. Smith 1959:202, emphasis added)

The Tokugawa was a period of relative evolutionary stasis, when the balance between local and supra-local management approached an efficient equilibrium. Though various "lords" expanded territorial holdings, none could centrally manage broad domains. Ironically, the close of the Tokugawa was brought about by processes that were not primarily concerned with managerial "capture" of the rural villages.

The decline of the Tokugawa period found villagers moving to cities, not (the administrative powers of) cities moving to villages. The huge urbanized power bases that did develop in the 18th and 19th centuries were largely coastal and relied on the agriculture and raw products from rural villages without interfering with the coordination of agriculture and irrigation (T. Smith 1959:67-123; cf. Eyre 1955).[11]

Japan illustrates that the size of a hydraulic system is one of the most important variables determining its administrative character. Bosserup reports that in the early 1970s "the irrigated and multicropped area per inhabitant in China was as large as the whole agricultural area per inhabitant in Japan" (Bosserup 1981:170-171). Bosserup suggests that preindustrial Japan was underdeveloped in comparison to China primarily because of the nonexpansive nature of its resource base and its reliance on maritime resources.

> There seems to be no doubt that what distinguishes Japan, is that Japan utilized poor resources efficiently and India and China utilized better resources poorly. (Bosserup 1981:171)

The world is full of examples of similar geographically limited, nonexpansive hydroagriculture systems. It is just such a hydroagricultural system that Barbara Price described in Late Post-classic Mexico as having "the multiplicity of individually limited water sources [with] localized distribution, [that] effectively barred the development of a unified and centralized basinwide single system" (Price 1981:226). The general neglect of Wittfogel's distinctions between hydraulic and hydroagriculture systems by scholars has resulted in a number of erroneous critiques, some of which are discussed below.

Wittfogel's Critics

Critiques of Wittfogel include those who disagree with the premise that the hydraulic state developed prior to the bureaucracy (e.g., Adams 1966; Adams & Nissen 1972; Butzer 1976 & 1980a); those who maintain that large irrigation works can operate without centralized control (Leach 1959 & 1961; Hunt 1989; Pfaffenberger 1989 & 1990) and those who believe Wittfogel hysterically saw hydraulic states everywhere he looked (Worsley 1984:106-107; Dunn 1982). Common to all these criticisms of Wittfogel is the argument that his region of expertise is confined only to China and southeast Asia, while the data used in Oriental Despotism is drawn from the Old and New Worlds.

I do not wish to be placed in a position of defending everything that Wittfogel wrote or said. I want only to salvage some basic principles of his theory from peremptory dismissal and to untangle a general hydraulic theory from the personal idiosyncrasies and political interactions of Wittfogel the man. Wittfogel was a prolific writer and there is much to disagree with. After his disillusionment with communism and the American political left, Wittfogel became obsessed with applying the model of despotism--originally developed for explaining the rise of riverine early states--to the fascism and totalitarianism he saw in 20th century nations that were not even hydroagricultural societies. In his blind political crusade, Wittfogel found hydraulic ghosts in every despot's closet. He was not capable of distinguishing between different forms of restrictive governments. All oppressive states became expressions of the same forces that gave rise to the hydraulically based ancient states of the Middle and Far East. The despotism of the Stalinist Soviet state was explainable to Wittfogel only in terms of Oriental despotism and imagined links to the hydraulic states of history. His model for understanding the peculiarities of a particular mode of production became his litmus test for interpreting all of sociocultural life. The tragic result of this obsession was his own testimony before the McCarran Subcommittee against scholars and former friends who were reported to be sympathetic to communism and Marxist teachings. Donald Worster notes,

> What had begun in the twenties as a search for scientific truth and positive laws of society had by the fifties become an elaborate web of inconsistencies, demonology, and ethnocentrism. (Worster 1985:28)

If Wittfogel's greatest error was his insistence on calling all hydraulic societies despotisms, then a close second was his muddled classification of all despots as Oriental despots regardless of their particular reliance on any form of irrigation. These were grave errors, but it is a mistake to disregard the whole of his theoretical contribution because of his ideological obsessions, as many social scientists have done. People with "bad politics" are capable of making valuable contributions to knowledge. The common contemporary dismissal of Wittfogel is exemplified by Varisco's comment that

> [the] ideological nature of Wittfogel's writings serves to obfuscate the issue of irrigation and its political consequences. By dividing the world into East and West, Orient and Occident, capitalist vs. Marxist, it is impossible to understand what is involved in the process of water allocation. (Varisco 1982:11).

Anthropologists studying irrigation no longer bother even to discuss Wittfogel's work, or merely cite it to dismiss instantly it as "reductionistic," "simplistic" or "mechanical." Most of the recent attacks against Oriental despotism come more from caricatures of Wittfogel than from close attention to his actual writings. One example of this is the widespread interpretation that Robert Netting's (1974) study of Swiss irrigation communities somehow demolishes Wittfogel's (nonexistent) position that all irrigation societies are despotic empires. The Swiss case does not represent an intensifiable network of canals, but is instead a small, nonconnected valley system fitting into Wittfogel's category of hydroagriculture.

Hunt's Critique

Robert Hunt is typical of contemporary critics of Wittfogel's theories in that he fails to discuss Wittfogel's model of hydraulic society in terms of the constraints and variables that Wittfogel himself recognized. This comment applies more to the recent views of Robert Hunt, whose earlier writings found more favor in Wittfogel's theories. Recently, Hunt published several articles criticizing the idea that large-scale irrigation systems necessitate the presence of state bureaucracies (Hunt 1988; 1989). Hunt's work suffers from two important mistakes: first, he does not utilize the hydraulic and hydroagricultural distinction, and second, he ignores differences in technology when comparing irrigation systems. He is not concerned with the role of irrigation in the formation of the state. Instead he attempts simply to demonstrate that something as basic as the size of an irrigation system does not determine if it is locally or nationally administered. Hunt's study examines the relationship between size and structure in 15 different cultures, but he unfortunately attempts to reject Wittfogel's model without establishing what this model is. Hunt (1988) does not even cite direct quotes or page references to any of Wittfogel's volumes of writings.

Instead of discussing features of hydraulic density or distinguishing between hydraulic and hydroagricultural societies, Hunt uses the categories of "size" and "character." But these are not the analytic categories found within Wittfogel's work. His reliance on "size" and "character" is particularly unfortunate given his previous cautions that Wittfogel's model must be examined in its own terms (Hunt & Hunt 1974).

Using this approach, Hunt creates a straw-man representation of a Wittfogel who is supposed to have denied that small irrigation communities could be regulated at national levels or that large nation states could have small, regionally independent irrigation systems. Hunt's study is built on the premise that Wittfogel thoughtlessly postulated a direct mechanical linkage between any scale of irrigation and despotism.

Hunt also does not attempt to control for variations in levels of available technologies. This is an important consideration because Wittfogel's theories on the development of early hydraulic states were premised on the prior existence of state-level bureaucracies because the long-distance coordination of water works could not be accomplished by any other <u>available</u> means. Today the existence and availability of heavy machinery, telephones, computer-based flow regulation programs, massive road networks and other technological aids make other forms of organization and coordination possible (though not always cost effective). All of the ethnographic examples cited by Hunt are found within nation states where governments greatly influence the organization and the massive engineering projects required for the system's very existence.

Wittfogel differentiated among four levels of "hydraulic density" based upon the degrees to which agricultural societies differ in their reliance on hydraulic agriculture (1957:166). He never claimed that the level of a state's control would co-vary with its size, but he did claim that "the bureaucratic density of an agromanagerial society varies with its hydraulic density" (Wittfogel 1957:167, emphasis added). The meaning of Hunt's data as it relates to Wittfogel's model is very different when levels of hydraulic density are considered instead of Hunt's own categories of "size" and "structure." Wittfogel defined hydraulic density as follows:

> A hydraulic society may be considered "compact" when its hydraulic agriculture occupies a position of absolute or relative economic hegemony. It may be considered "loose" when its hydraulic agriculture, while lacking economic superiority is sufficient to assure its leaders absolute organizational and political hegemony. (Wittfogel 1957:166)

Wittfogel defined this division:

> The core areas of the hydraulic world manifest at least two major types of hydraulic density. Some are hydraulically compact, whereas others are hydraulically loose. A hydraulic society may be considered "compact" when its hydraulic agriculture occupies a position of absolute or relative economic hegemony. It may be considered "loose" when its hydraulic agriculture, while lacking economic superiority is sufficient to assure its leaders absolute organizational and political hegemony. (Wittfogel 1957:166)

By disregarding technology and factors of hydraulic density, Hunt misrepresents Wittfogel's model. The state-owned and -operated technology (e.g., dams, federal canal projects, massive road works, etc.) of all 15 of these irrigation systems is not discussed by Hunt as constituting an important variable. A fifth of the examples used by Hunt are located in the United States and were classified as being locally administered (King's River, Fresno, New Cache Col.). All of these projects were built under the auspices and funding of the Federal Government. Each of the areas has a history of receiving federal operating funds. Infractions of water rights are indeed mediated primarily at a local level, but the state's authority is absolute. All of this begs the question, At what point is it useful to characterize an irrigation system as "national" or "community"?

Wittfogel further clarified this division by providing historical and ethnographic examples of each of these categories as follows:

<u>Compact 1</u>: Most Rio Grande Pueblos, the small city states of ancient coastal Peru, Pharaonic Egypt.

<u>Compact 2</u>: The city states of ancient Lower Mesopotamia, probably the state of Ch'in on the eve of the Chinese empire.

<u>Loose 1</u>: The Chagga tribes, ancient Assyria, the old Chinese state of Ch'i and perhaps Ch'u.

Loose 2: Tribal civilizations: The Suk of East Africa, the Zuni of New Mexico, state centered civilizations: indigenous Hawaii, many territorial states of ancient Mexico (Wittfogel 1957:166).

Another determinative variable used by Wittfogel (and ignored by Hunt) is called "the pattern of proprietary complexity." Wittfogel devoted over seventy pages of Oriental Despotism to the topic because

> an institutional analysis of hydraulic society should deal not only with the density of its agromanagerial apparatus but also with the complexity of its proprietary development. (Wittfogel 1957:229)

Proprietary complexity is a measure of irrigation societies' control over land and other pertinent property (Wittfogel 1957:228-300). These property relations are divided into the categories of "simple," "semicomplex" and "complex," each of these categories denoting varying degrees of centralized control over property (1957:230). The conception of proprietary complexity negates Hunt's claim that Wittfogel simply correlated size with despotism. The principle of proprietary complexity clearly recognizes that the particular circumstances of a given irrigation environment influence the degree or nature of centralized control.

Table 1-1 compares Wittfogel's (1957:166) classification of societies into categories of hydraulic density with Hunt's generalizations (C1, etc.). Wittfogel's

TABLE 1-1

NAME OF IRRIGATION SYSTEM	HUNT	WITT	HECTARES
1--San Juan, Mexico, 1964	LOCAL	L1	600
2--Tayuban, Java, 1983	NATIONAL	C1	700
3--Zanjera Danum, Philipienes, 1970	LOCAL	L1	1,500
4--Vicente Guerrero, Mexico, 1982	LOCAL	L1	1,575
5--Moncada, Valencia Spain, 1968	LOCAL	L1	5,500
6--Moerlia, Mexico, 1982	NATIONAL	C2	7,000
*7--Go, Japan, 1950	LOCAL	L1	8,000
*8--New Cache, CO, USA 1969	LOCAL	L1	15,400
9--Angat River, Luzon, Philippienes, 1964	NATIONAL	C1	26,890
10-Rio Mayo, Mexico, 1983	NATIONAL	C2	95,973
*11-Fresno, CA, USA, 1969	LOCAL	L1	97,000
*12-Chia-nan, Taiwan, 1968	LOCAL	L1	150,000
13-Hindiyah, Iraq, 1957	NATIONAL	C2	209,000
*14- King's River, CA, USA, 1969	LOCAL	L1	458,000
15-Gezira, Sudan, 1964	NATIONAL	C2	730,300

* = Groups whose "local" classification is questioned. Wittfogel's Hydraulic Density Variables: C1 = Compact 1, C2 = Compact 2, L1 = Loose, L2 = Loose 2.

TABLE 1-1 shows Hunt's 1988 classification of fifteen irrigation systems compared with Wittfogel's hydraulic density factor.

variables of hydraulic density and technology are matched with Hunt's "local" and "national" designations.

A small system managed nationally is less of a challenge to Wittfogel's model than is a large system administered locally. The five largest (each over 5,500 ha.) of the so-called "local" irrigation groups are examined a case at a time below. The cases where areas of over 6,000 hectares of land were managed at a national level require no further explanation because these are not thought by Hunt to run counter to Wittfogel's theory. The examples discussed below are the cases Hunt believes disprove Wittfogel's theory.

Go, Japan. As discussed above, the nonexpansive, geographically limited ridge and valley systems of Japan have historically constricted the economic returns and levels of efficiency to be gained by state level water management.

New Cache, Colorado. The "local character" designation of water management for South Platte-Cache La Poudre, Colorado, is not accurate. Hunt is referring to the "irrigator-owned cooperatives" that oversee the local "operating rules and regulations" (Maass & Anderson 1978:289). True, this is a local charter, but in truth its power is not local, and its role in the process of providing water is minuscule compared to the state and national administrative bodies and programs. There are state engineers who are "charged with administering the distribution of the water" (Maass & Anderson 1978:294). It is the state, not the local charter that regulates the South Platte River through its reservoirs. It is the state that has the real authority to reprimand irrigation violators, not the local charter. Hunt's line of reasoning begs the question of whether federal agents need to get their hands wet in every irrigation task before he is willing to concede this is a federally operated program.

Fresno, California. The formation of Public Irrigation Districts in Fresno suggests to Hunt that there is a local, rather than federal authority base. The primary purpose of Public Irrigation Districts is to issue bonds and collect taxes for the "annual costs of operating and maintaining the irrigation system" (Maass & Anderstand 1978:174). But does the Public Irrigation District really control the irrigation system more than does the federal government? By no means. As with the New Cache, Colorado, system, it largely functions as a local broker for federal interests. As such, it enters "into cooperative and contractual arrangements with agencies of the federal and State government" (Maass & Anderson 1978:174). Indeed, this "local" system would be high and dry without federal management and the construction of the Pine Flat Dam and Reservoir. As noted by Maass and Anderson (1978:375), "Local control does not necessarily mean control by the least advantaged or control for their benefit."

King's River, California. The King's River community is so propped up by federal programs that it is odd for Hunt to classify it as an "irrigation community." While it is true that the administrators of the King's River system live in the local area, it is a mistake to state that their power is local power. Clearly, the federally built and administered aqueducts, maintenance roads and dams demonstrate the supra-local nature of the system.

In the past Hunt has contributed much to the cross-cultural study of irrigation, but his work contrasting locally and federally administered projects has a stunted view of the role of many federal programs. He treats many massive reservoir/canal projects as local entities without addressing the federal contribution to their construction or maintenance. Hunt's inappropriate expectation that state controlled irrigation systems should have some sort of absolutist control over all aspects of irrigation leads him to misclassify many state-coordinated systems as locally administered. This is a sort of "straw-man" argument employed by many irrigation researchers who believe that the high levels of <u>inefficiency</u> found in large irrigation projects around the world evidence the lack of power held by the managerial state. Hunt is not alone in his expectation that to qualify as a national, centralized irrigation system, all aspects of irrigation must be controlled by state-level institutions. As we shall see, even in the Fayoum this is not true.

Summary and Conclusions

Though the management of the Fayoum's irrigation is highly centralized, we have examined the difference between hydraulic and hydroagricultural societies to illustrate the basic differences between these systems. The past failure of Wittfogel's critics to differentiate between hydraulic and hydroagricultural societies has allowed an overall unfair dismissal of his theory of hydraulic societies. Most of Wittfogel's critics have confused the presence of local operatives with decentralized irrigation systems.

Before considering the modern organization of Fayoumi irrigation, we first examine Karl Butzer's influential rejection of Wittfogel's representation of Dynastic Egypt as a classic hydraulic society. As we will see, Butzer does not misrepresent Wittfogel's hydraulic hypothesis; instead, he claims the artifactual and demographic evidence from Dynastic Egypt demonstrates a decentralized state--counter to Wittfogel's model.

Notes

1. Others, with more sympathetic concerns with irrigation societies, have recognized the crucial distinction between hydraulic sources, for example:

> Wittfogel's theory can also be turned around to illuminate the nature of state systems with rainfall agricultural infrastructures. Such states possess evolutionary potentials entirely different from hydraulic systems. Rainfall agriculture leads to dispersed, multicentered forms of production. (Harris 1979:104-105)

See also Fried 1967:210.

2. Jon Elster goes so far as to write in jest that "there are in Marx's work only 2.5 [sic] explicit references to the Asiatic mode of production" (Elster 1985:257; personal communication).

3. However, numerous notebooks and manuscripts of Marx did contain notes and references to expanded comments on the Asiatic mode of production (see Krader 1972 & Krader 1973).

4. Lawrence Krader noted an initial difference in approaches between Marx and Engels where

> Marx changed Engels' formulation: Marx ended with a question of the means of production, irrigated agriculture, Engels with a question of the form of property. Marx proceeded from the abstract to the concrete: the overflow of the rivers . . . [was] . . . rendered useful in increasing the fertility of the soil. (Krader 1975:87)

5. See Dunn 1982, <u>The Fall and Rise of the Asiatic Mode of Production</u>. Wittfogel appreciated the evolutionary and political significance of Marx's and Engels's theories on Asiatic society.

> Marx and Engels' acceptance of Asiatic society as a separate and stationary conformation shows the doctrinal insincerity of those who, in the name of Marx, peddle the unilinear construct. And the comparative study of social conformations demonstrates the empirical untenability of their position. Such a study brings to light a complex sociohistorical pattern, which includes stagnation as well as development and diverse change and regression as well as progress. By revealing the opportunities as well as the pitfalls, of open historical situations, this concept assigns to man a profound moral responsibility, for which the unilinear scheme, with its ultimate fatalism, has no place. (Wittfogel 1957:7-8)

6. This article has been translated into English under the title "Geopolitics, Geographical Materialism and Marxism" by Koeppl, Lyons and Ulmen and published with an introductory essay by Richard Peet (Peet 1985).

7. There are also aspects of Wittfogel's hydraulic theory that are muddled with contradictory statements on the determinative powers of infrastructure and structure. At different times and places he vacillates between crediting structural and infrastructural forces with the ability to create Hydraulic societies. In a number of instances Wittfogel claims that "cultural conditions" (read: "cultural beliefs and values") determined the formation of hydraulic societies. Consider Wittfogel's statement that

> hydraulic society cannot be explained by reference to geographical, technological and economic factors alone. <u>While response to the natural setting is a key feature, it plays a formative hydraulic role only under very specific cultural conditions</u>. And it involves

> organizational rather than technological changes. (Wittfogel 1957:161, emphasis added)

Wittfogel's claim that Oriental despotism evolved in regions without hydraulic resources is the most obvious result of this theoretical stance that dismisses the absolute importance of infrastructure. Wittfogel leaves us with no hope of understanding the genesis of "cultural conditions" beyond the assumption of primordial atavistic roots (see also Wittfogel 1955; 1967; 1971).

8. For example, Teotihuacan is a somewhat decentralized river-fed system that never became a classic hydraulic state, though it did achieve a greater degree of control over the periphery than occurred in (for example) the spring-fed regions of Yemen.

9. There are numerous other instances where Wittfogel makes this same point. For instance,

> [irrigation farming] requires radical social and political adjustments <u>only in a special geohistorical setting</u>. Strictly local tasks of digging, damming and water distribution can be performed by a single husbandman, a single family, or a small group of neighbors, and in this case no far-reaching organizational step is necessary. Hydroagriculture, farming based on small-scale irrigation, increases the food supply, but it does not involve the patterns of organization and social control that characterize hydraulic agriculture and Oriental despotism. (Wittfogel 1957:18, emphasis added)

10. Perry Anderson's analysis of the formation and scope of Japanese feudalism unfortunately puts the structural cart before the evolutionary infrastructural horse. For example he writes, "The lack of anything like a mandarinate proper within the bureaucracy rendered it prone to noble privatization from the start" (Anderson 1974:435). This mistake of lumping a culture's structure with its infrastructure is unfortunately not peculiar to Anderson.

11. These coastal-urban centers of power included some of the world's largest cities for their era. Smith noted that

> Edo, no more than a fishing village in 1590, grew into a vast and crowded city of more than half a million by 1751, when it was perhaps the world's largest city. Osaka and Kyoto grew less rapidly, but both had populations of 400,000 or more by 1800; together with neighboring Sakai and Fushimi they comprised an urban

center of nearly a million people. (T. Smith 1959:67-68)

CHAPTER 2
THE POWER OF THE STATE: BUTZER'S SOFT ECOLOGY

> The reason that the primary state zones were primary was that at a critical cultural evolutionary stage in which technology was scarcely more than neolithic, and economic and political organization were relatively uncomplex, gross environmental limitations such as scarcity of water or arable land fixed populations firmly enough in place to allow the process of intersocial competition to continue in a sufficiently extended and intense fashion to produce a kind of sociocultural "implosion."
> ---Malcom Webb

In his book, Early Hydraulic Civilization in Egypt Karl Butzer, analyzes the development of the natural and cultural setting of early Egypt and advances an anti-centralized hypothesis directly opposed to that of Wittfogel (Butzer 1976). This book has now assumed a position of central importance for any work discussing the influence of irrigation in general and in particular the development of Egypt's Dynastic state. Amassing what appears to be a great deal of stratigraphic and paleogeographic data, Butzer pieces together a general picture of Egypt's prehistoric climates, flood levels, population levels, and general ecological settings. All of this leading toward the apparently inescapable conclusions that: (1) the Egyptian state did not centrally control irrigation and (2) social rather than Infrastructural forces caused the rise of the

Egyptian state. Early Hydraulic Civilization is a difficult book to critique because of its unrivaled position of authority among Egyptologists concerned with early irrigation and because of its elusive construction. In large part this elusive construction is achieved by Butzer presenting table after table of quantified qualitative data while adding only in passing, the proviso that "none of the numerical data are to be taken literally" (Butzer 1976:76)! Ignoring for a moment Butzer's own advice that his own data is not to be taken literally, there is the larger question of what is to be done with such an influential work.

Butzer rejects the theory of Oriental Despotism because he believes Wittfogel's ecological perspective to be "crudely simplistic" (Butzer 1976:xiii). Butzer believes the evolution of the Egyptian state is uniquely different from other riverine societies and that it is misleading to generalize about hydraulic societies (1976:112). Butzer's model of Dynastic Egypt's evolution features a primacy of governmental bureaucratic structures over matters of hydrology.

Data Problems

Butzer concludes that the Dynastic state was only marginally involved in the organization and supervision of irrigation. It is only with hesitation that he admits some episodes of Dynastic collapse were caused by irregular Nile levels. Butzer's hesitancy has more to do with the protection of his model than with facts. He is hesitant because if there were no connection between state power and state control over agriculture, then these crop failures should not have been able to produce Dynastic collapses. Low Nile floods are thus only interpreted as having been a "plausible" contribution to the demise of the Old Kingdom (Butzer 1980a:522). "Nile failure" is seen as being a co-agent of the New Kingdom's collapse and "aberrant Nile behavior" is a contributing factor to the end of the Second Dynasty and the late Middle Kingdom (1980a:522). But none of this suggests to Butzer, that the irrigation infrastructure determined Egyptian social formation and Dynastic succession.

> The co-agency of Nile failure in the New Kingdom collapse is beyond question, and in the disintegration of the Old Kingdom, plausible. In Second Dynasty and late Middle Kingdom times, aberrant Nile behavior is not only the single external variable in evidence but the most prominent agent overall. This does not attribute the role of a determinant to Nile behavior. Instead, at a given level of technology, the Nile ecosystem provides a set of opportunities and constraints to agricultural productivity, varying from season to season, as well as from year to year. (Butzer 1980a:522)

For Butzer the role of irrigation and the Nile are mitigated by the structural power of the state.

Butzer's data problems are also acute when it comes to demographic conditions during Dynastic times. These data are extremely limited in their specificity. We have no raw population numbers, and therefore have basic problems when it comes to extrapolating population pressure levels.

Butzer has thus far failed to publish a convincing body of specific evidence supporting his generalized demographic modeling of Dynastic Egypt.

The methods and models which Butzer (1976), Hassan (1973; 1980b), Schild and Wendorf (1981) and others base their environmental and demographic inferences upon are open to criticisms and questions. All models of prehistoric population levels are severely limited, and cannot be argued to have developed to the point of establishing exact fluctuations corresponding to the changes of new Dynastic administrations.

The bulk of the paleoenvironmental data used by Butzer is little more than "mights", "maybes" and "could have beens." There are projections of landmasses that <u>might</u> have been subject to cultivation during a given period, coupled with projections of <u>possible</u> productivity rates. There are not even data which demonstrate the scale of the loss of lands due to mismanagement by Dynastic leaders. I do not complain that these methods are without their uses, only that Butzer moves well beyond the authority of the data to read minute changes in the demo-ecological setting that cannot be perceived in their individuality. These models can be used to give us a generalized picture of the demographic setting, the possible extent of agricultural production, and broad estimates of habitable lands.

We do know the generalized macro changes in population trends, but we do not know the shifts in usable lands that fluctuated with the various shifts in administrations. This is a distinction crucial to an evaluation of Butzer's argument about changes in demography which co-vary with the passing of Dynastic regimes.

Butzer derives Dynastic population densities not through field oriented inquiries but by following Klaus Baer's (unpublished) assumption of a population density of 184 per square kilometer (see Butzer 1976:76-77).[1] In Butzer's Egyptian analysis as a whole, there is no empirical study of demographic data, but only a philosophical declaration of supposed demographic processes. As Butzer himself put it, "<u>the available Egyptian evidence, combined with a selection of external paleodemographic and cross-cultural ethnographic materials, allows little more than speculation as to the evolution of demographic patterns through time</u>" (Butzer 1976:81). If one is going to "speculate as to the evolution of demographic patterns" it is important to be perfectly clear (and cautious) about the limits of such speculation.

Problems of "Infrastructure" and Demography

Butzer does analyze some available Infrastructural data, though he sees no reason to treat these features as independent variables in the formation of the Egyptian state. Butzer is not only hard pressed to isolate any such independent variables, but he does not recognize the infrastructure of the state as being markedly different from its technological and ecological precedents. For him the state's relationship to economic production was epiphenomenal.[2] His model of Dynastic formation is structuralism in ecological clothing.

> Although Old Kingdom Egypt was centralized in terms of its political superstructure, there is reason to assume that the infrastructure, at least in Upper Egypt, continued to function on more traditional lines via several indirect agents and agencies that mediated between Memphis and the local communities. . . .The development of a professional full-time bureaucracy must therefore be related to a different social impetus. In other words, there is no direct causal relationship between hydraulic agriculture and the development of the Pharaonic political structure and society. (Butzer 1976:110)

What does Butzer mean by "infrastructure" in the above paragraph? Does he mean the physical equipment used in irrigation, or does he actually mean the structural organizational features of the system? We must assume he is referring to the structural managerial components of the system. If this is so it reveals a confusion on his part over any (not just a cultural materialist) definition of infrastructure. By "infrastructure" he clearly does not mean demography, economy, environment or technology. He does not mean "public works", rather he seems to mean the (social) management of public works.

Setting aside this confusion over the meaning of infrastructure it is vital to recognize that Butzer's rejection of the importance of infrastructural conditions is not limited to his analysis of Egypt. Concerning all human prehistory Butzer has concluded that "we have yet to identify an instance where demographic pressure actually preceded shifts in prehistoric technology or settlement" (Butzer 1978b:127).[3] This is surely an exaggerated claim, and one contradicted by a variety of sources not the least of which is Butzer himself:

> Population would appear to have quadrupled in the 1,500-year period preceding the apex of the Old Kingdom, suggesting a net growth rate of modest proportions (0.8 per 1,000) but placing considerable pressure on resources. (Butzer 1976:86, emphasis added)

Just what does Butzer mean by "demographic pressure"? Does he mean raw population growth? It is clear from Butzer's writings that he simply means increased population. But of course this is not what population pressure is.

Population pressure is not a binary trait of ecological systems. It is not an attribute that is simply present or absent in a given population. All populations exist in environments that exert selective pressures upon them. As is widely recognized, population pressure

> may be felt even while a population is not increasing, if standards of living are low and the means used to maintain population at low level are themselves costly. . . .Thus, while production sets limits to population growth, population pressure provides the motivation to overcome such limits. (Harris 1988:264-265)

Cultural adaptations at times allow humans to alter environments (with technologies) thus enabling them to support greater populations than would be possible in the absence of these adaptations, but this does not mean that population pressure ceases to exert influence on them.

Population (or "demographic") pressure exists for all species, always. All environments have finite limits. A given species or cultural group may live far below the carrying capacity of a techno-environmental setting, but there still exists a level of demographic limits (Harner 1970).

Butzer's rejection of the importance of demographic pressure has had a far reaching influence on Egyptology and the study of Egyptian prehistory, but this general contention is at variance with more generalized models of state evolution and population demographics (see Harris 1977; E.L. Jones 1987; Boserup 1965; 1981).

There are several general inconsistencies in Butzer's model. When he addresses issues of state omnipresence and demographic pressure he wants to have it both ways in terms of causality. He wants to show demographic pressure as incapable of generating political changes, (on the scale of a Dynastic collapse) so he extols the ability of the state to effect changes in population levels. In discussing the deterioration of various Dynastic regimes he writes that,

> Each phase of political devolution was accomplished by economic deterioration and temporary or substantial demographic decline. (Butzer 1976:518)

When discounting the existence of a centralized, all-controlling state he claims there was little reliance on the state for the construction and maintenance of public works. Yet at the same time he also claims that there is a recurrent pattern of political devolution causing patterns of demographic decline, a process in which administrations fall apart and in turn cause populations to decrease. Doesn't his recognition that political collapse leads to population decline imply a major reliance on some sort of centralized state?

The crux of this problem is made clear in Butzer's article "Civilizations: Organisms or Systems?" in which he describes a repetitive pattern in Egyptian history. It is here that he argues that each past administration reached a point of collapse and "political devolution [that] was accompanied by economic deterioration and temporary or substantial demographic decline" (1980a:518). Note that Butzer is implying that there are forces being brought to bear that are the opposite to those posited by a demographically determined argument. He concludes that political devolution <u>causes</u> demographic decline.

Butzer does not clarify just what causes political devolution in the first place, but he does list four variables which contribute to periods of decline. Two of these are psychological in nature, the remaining two are either historically idiosyncratic or unwittingly infrastructural explanations.

The first is identified as a pattern of "a progressive social pathology" and despotism among these leaders which results in "social disequilibrium and eventual politicoeconomic collapse" (Butzer 1980a:521). The second hinges on the personality traits of the leader (1980a:521). The third feature leading to decline is foreign military intervention. Finally, the last in his list of variables leading to collapse mentions infrastructural variables.

> A fourth critical variable is ecological stress as a result of Nile behavior. The co-agency of Nile failure in the New Kingdom collapse is beyond question, and in the disintegration of the Old Kingdom, plausible. (Butzer 1980a:522)

The first two explanations are intellectually unsatisfactory and account for nothing. To say that political decline is caused by unsuccessful leaders or some form of "social pathology" is simply an <u>de facto</u> pronouncement that winners are those who win and loosers are those who loose.[4] The third and fourth explanations are worth considering. Of course suggesting military intervention as a cause of decline negates Butzer's main argument that these periods of decline occurred <u>prior</u> to the formation of new administrative periods. The timing of the collapse before these new administrations is the entire point of Butzer's argument, thus the cases of military invasion can not be the "cause" of decline--if Butzer is to remain consistent--but is instead only a symptom. Butzer clearly did not think through all the implications of his explanations of political decline for the rest of his model. This leaves us with only one cause for political devolution left, that being the ecological variation of the Nile.

Butzer illustrates the overall patterns of decline and florescence of Egyptian history with a diagram tracing shifts in Egyptian population trends from the Predynastic period to the formation of the Islamic Period (see Figure 2-1, based on Butzer 1980a:519). The purpose of this chart is to illustrate the absence of a causal correlation between high demographic pressure and the formation of states or the introduction of new administrations. But the data and variables Butzer used to construct this diagram can more parsimoniously be interpreted as proving the opposite conclusion.

For the purposes of this critique, let us assume that the following data used by Butzer are correct: chronology; cultivable land area; and population. The only variable I wish to challenge as incorrect is Butzer's assumed measure of population density--which for him increases after, not before, the beginning of a new administration (structural) or mode of production (infrastructural).

Butzer describes the life history of each Dynasty as beginning with an "apex" of "strong, central government, followed by a long period of stagnation and eventual decline" (1980a:518). A vital feature of these later periods of "stagnation and eventual decline" includes the neglect of hydraulic works. This would necessarily lead to the widespread reduction in available arable lands.

The important point that Butzer misses is that such a reduction of arable lands would logically result in an increase of population pressure. As a given administration's mismanagement created more un-arable lands the effect most logically occurring would be that populations found themselves occupying less and less land. Did this automatically mean that there were somehow instantly fewer people? By no means. It meant that roughly the same population would be living in a reduced area, and thus <u>an increase in population density preceded the formation of a new regime</u>.

This process of increased population density at times of environmental or managerial collapse is well known in other cultures. The demographic and political changes of fourteenth century Europe were the result of just such processes. Urbanization increased with deforestation and environmental degradation. The collapse of the Mayan state in the New World is another well known example of intense urbanization during agricultural collapse (Turner 1989). Yates' study of war and food shortages in Dynastic China found similar "great waves of migration" during periods of centralized managerial collapse (Yates 1989:171). The great

Dust Bowl in the south-central United States is another instance of increased population density during an epoch of both environmental and managerial collapse (Worster 1979). The historical instances of this pattern are almost endless.[5]

Though Butzer recognizes that at the end of each Egyptian kingdoms' rule, the irrigation works fall into disrepair, he fails to incorporate this in his calculations of population pressure. He is correct that given a state of disrepair there was less cultivable land during these periods of decline. There are however, questions of how much land was left arable. If half as much, it must still support about the same number of people, which would mean twice the population pressure. Butzer's own model inadvertently suggests there was increased population pressure prior to the fall of each Dynasty. Even if population levels were reduced, many survivors of these epochs could be starving to death. And that is certainly a feature of extreme population pressure. The overall changes which Butzer models are seen on the column in Figure 2-1, I have marked the diagram to indicate periods of increased population pressure along the column.

Again, these charts are constructed only on the assumption that Butzer's data are correct. Figure 2-1 is a (substantially unaltered) reproduction from Butzer's article (1980a:519). The column of Figure 2-1 incorporates an overall land reduction of only 20% for time periods preceding dynastic collapse (as anticipated by Butzer--though he does not supply a numerical estimate of exactly how much land might be expected to have been unusable). A level of population reduction is assumed at only 5%.

As new regimes come to power, raw population increases (as Butzer shows), and logically so does the amount of agriculturally utilized land, thus decreasing the level of demographic pressure. The amount of agricultural land then increased by reclaiming lands previously unusable (due to the negligence of the previous administrations). Following Butzer's cycle, time passes, and this pattern of neglect of public works occurs and reoccurs (again, this is also a feature of Butzer's model), and as neglect continues, less land is cultivable and population density of habitable land increases (represented by xxx in Figure 2-1).

Unfortunately, as I have said, precise data on the area of land mass lost during these periods of decay--prior to the establishment of new administrations--are unavailable. This is a factor that limits my argument, but it limits me no more than it does Butzer, for it is also an important basis for his claims and projections. This is clearly an area where future work is needed. On the available Egyptian data alone, my argument is at least as strong as Butzer's. When the philosophical assumptions to both arguments are

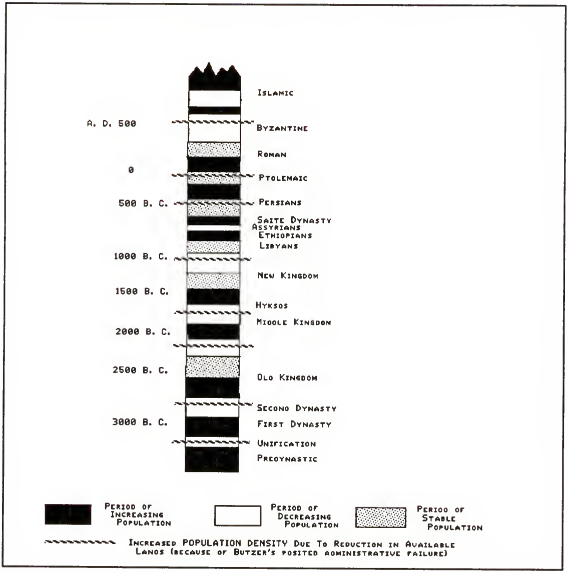

FIGURE 2-1

Figure 2-1 is a direct representation of Butzer's (1980a:519) Figure 3, except for the inserted lines indicating increased population density as discussed in the text below. As irrigation works failed through neglect, lands were abandoned. As indicated in the figure, these populations thus had less land area to farm and live on and population pressure actually increased.

considered, there is little more to support the Butzer's mechanisms of growth and decay other than the moral spirit of the time in question.

Dickson expanded upon Robert Carneiro's (1970) general circumscription theory of state formation and produced a model reminiscent of Butzer's cyclical theory of Egyptian florescence and collapse (cf. Carneiro 1988 Graber & Roscoe 1988; Webb 1985 &1988). However the orientation of Dickson's theory is clearly infrastructural. Dickson describes the development of Mesopotamian Dynasties through a recurrent pattern of land depletion and human generated catastrophe. Attempts by pre-state (Ubaid) populations at irrigation farming in the southern alluvium led to widespread salinization of soils. Because this pattern of land depletion is "cultural" rather than "natural" Dickson designates this as a pattern of "artificial circumscription" (Dickson 1987:709).

Dickson's catastrophic model isolates patterns of state collapse reminiscent of Butzer's Egyptian model. Dickson's model of the process of collapse and re-development has general parallels in the early history of Egypt. Just as the early Mesopotamian countryside was overwhelmed by "progressive anthropogenic environmental destruction" (pp 709), so it was with various administrations that neglected the maintenance of Egypt's public works. This pertains particularly to public irrigation works, which were the basis of economic production. The neglect of public irrigation works as described by Butzer would lead to just such a catastrophic collapse of Egyptian Dynastic states.

<u>The Fayoum is not a Dynastic Exception</u>

The Fayoum presents a special problem for Butzer's theory of minimal state presence. The archaeological remains of the 8 kilometer long al-Lahun Dam is a difficult piece of evidence to overlook (as well as the evidence of massive dredging, diking, and swamp reclamation). To overcome the burden of this evidence Butzer concludes that the Fayoum was not typical of the rest of Egypt.

> The Faiyum provides a special case, with some regulation of lake level and a first stage of colonization achieved in the Middle Kingdom. (Butzer 1976:108)

Butzer is mistaken in assuming that the hydraulic administration of the Fayoum was an exception. The state's prominent managerial role in the Fayoum's hydrology is not an exception. I concede that the Fayoum has always required a <u>higher level of centralized management than the rest of Egypt</u>, but this is far different from saying that the state's intervention in the Fayoum is an exception. The Fayoum has always required more centralized irrigation control than the rest of the Egypt because of it's particular reliance on gravity-fed irrigation.

Butzer and the State

This dissertation does not set out to prove that all of Dynastic Egypt was a despotic-hydraulic state. However, Butzer's assertion that the Dynastic Fayoum is somehow just a "special case" of state interference in irrigation must be addressed. If Butzer is correct that the Dynastic Fayoum was a special case, it could be argued that the whole of Dynastic Egypt was **not** an hydraulic state. There is abundant evidence that the Fayoum was not the only region to have such levels of centralized management during Dynastic times. So that Butzer's claim that the Fayoum is a special case does not go unanswered. Some of this evidence is briefly discussed below.

Even Butzer cannot escape the reality that Pharaohs were absolute despots. Butzer wraps his argument in a paradox when he admits that Old Kingdom Pharaohs' powers "[appear] to have been virtually absolute, but the implementation of central authority is less clear" (Butzer 1976:110, n.1). This paradox tells us much about Butzer's thesis, and its high evidentiary demands that proof of state centralization must be directly traceable not to local agents of the state, but to the throne of the Pharaoh himself. This begs the point of just what Butzer thinks a strong centralized state is. Centralized states are not omnipotent entities, unable to do anything at a local level without the approval of the capital. Centralized states have localized agents working toward the goals and policies of the state. Butzer frequently refers to localized branches of Dynastic institutions as if they were disassociated from the rest of larger government.[6] Butzer observes that,

> Examination of the impact of strong and deficient floods on such a rudimentary and locally organized irrigation system suggests that the apparent redistributory and managerial functions of the local temples, at least during the New Kingdom, would have been of paramount significance in coping with the vagaries of the river. (Butzer 76:108)

An ecological feature as widespread as deficient floods is framed as merely a **local** issue. This tendency to idiosyncracize the universal is common in Butzer's work. No one denies that crop failures--due to low floods--occurred in local settings, nor is it denied that the agencies that coped with these failures operated at local levels, but the location of an active agency does not reveal the source of it's power (nor even it's ability to operate as an individual entity). Local agents do not necessarily mean localized control (see also Butzer 1978a & 1984).

Butzer views the Dynastic state as simply "refining" the existing forms of natural floodplain irrigation throughout Egypt. The state was not responsible for massive, coordinated efforts and labors, but instead performed,

> <u>refinements</u> on the natural system of irrigation, the efficiency of which can be greatly improved by a relatively limited input of labor. (Butzer 1976:20, emphasis added)

All of this sounds reasonable enough until a listing of the sorts of labors he defines as "refinements" is considered: "annual dredging or deepening of. . .natural channels", "diverging overflow channels", "the digging of short ditches to breach the low points of the natural levees", "blocking off the gathering streams by earthen dams", "the use of buckets to raise water manually from the residual ponds or natural channels to adjacent fields"(Butzer 1976:20), "modifications of river channels, levees, and flood basins" (Butzer 1976:41, emphasis added). If these are only refinements, what would Butzer consider to be major innovations? Given the scale at which these tasks were performed it is odd for Butzer to insist a "relatively limited input of labor" was involved (Butzer 1976:20). These "refinements" are the same forms of labor that other analysts refer to as "massive" (Wittfogel 1957), "leviathan" (Worster 1985), or "monumental" (Kees 1961).

Goyon and others have modeled a much more proactive Dynastic hydraulic state. Goyon believes Old Kingdom Pharaohs supervised the building of massive canal networks, including a giant canal connecting the Fayoum's Bahr Yusef canal system with the Giza Pyramid complex sixty kilometers to the north (Goyon 1971). Butzer admits that such a massive canal could have existed, but curiously dismisses its importance as being "superfluous from the perspective of navigation or irrigation" (Butzer 1976:46, note 2). Butzer likewise tries to dismiss Sneh, Weissbrod and Perath's (1975) and Sneh & Weissbrod's (1973) evidence of gigantic Dynastic canals along the northeastern Delta.[7]

Butzer argues that the absence of Dynastic legal documents pertaining to water rights is evidence that such legislation was

> not overly complex, and that it was administered locally. The fact that many other aspects of civil and criminal law were codified repeatedly in response to new economic or social situations argues that water legislation belonged within the oldest oral traditions of common law. It further implies that such legislation accumulated in prehistoric times, prior to the establishment of any centralized political superstructure, yet required no formal modification in later millennia. (Butzer 1976:109)

This is a curious argument. There is of course some documentary evidence that the Dynastic state dictated water rights. One such example even shows the administration of Amenemmes "restricting each district's supply of Nile water for irrigation" (David 1986:28).[8] Other literary references to Dynastic irrigation activities show priests directing canal work throughout Egypt. One letter from the Ramesside Period states that,

> The priest stands as a cultivator and the novice works on the canal. . .he is wet through in the river and he makes no distinction between winter or summer, whether the sky is windy or whether it is raining (Papyrus Sallier cited in Kees 1961:61).

There are a variety of possible reasons for the overall rarity of Dynastic irrigation documents. In general, there are persistent problems of absent data in almost every aspect of archaeology and ethnology. Perhaps the absence of laws is simply a case of not stating the obvious, or simply another gap in our basic knowledge of Egyptian prehistory. Barry Kemp offers a parsimonious solution to Butzer's complaint by simply pointing out that we know almost nothing about Dynastic titles and their functions.

> <u>Very few administrative documents have survived from the Old and Middle Kingdoms</u>, too few to reveal the full structure of government at any one time, let alone to enable its historical development to be traced in any detail. In their place we must rely heavily on the very numerous titles born by officials. <u>A major difficulty here is that titles were not necessarily descriptive of jobs, but could serve to place a man in the hierarchy of power and thus indicate his rank relative to his fellow</u> (Kemp 1983:80, emphasis added).

Another way of looking at this lack of evidence is to consider what sort of records exist from more modern despotic periods. During the late 19th century--a period we shall see characterized by despotic state control and brutal corvee--the French hydrologist Barois commented on this same absence of hydraulic laws from both his own era, and from ancient times.

> Such an omission [of "special regulations for the use of water"] is, in fact, strange in a country which owes its existence to the waters of the Nile, but where Arabian rule has been established for many years, which left in Spain such remarkable specimens of rules and regulations for irrigation. (Barois 1887:99)

Barois noted that even in an epoch as despotic as the Khedive period,

> there are no laws or regulations to give any particular point a determined portion of the discharge of a canal,

> or to maintain in it a fixed level for the surface of the water. (Barois 1887:99-100).

Perhaps if modern students of the Khedive period could only access the same sort of fragmentary records as Egyptologists, they would mistakenly concluded--as Butzer has for the Dynastic period--that there was no centralized state. But despite the rarity of specific Khedival hydraulic laws and regulations, Barois was able to observe first hand that,

> the entire country requires that a single individual authority should regulate the general distribution of the water of the river, the only source of wealth of the inhabitant, and protect the cultivated lands from inundation (Barois 1887:99, emphasis added).

Again, despots do not need rule books. The fact that they are in control is self evident, further expositions of this fact become redundancies in the face of such obvious truths.

Given the wide range of subjects for which no textual evidence exists for Dynastic periods (including pyramid construction & decoration, king lists etc.), Butzer's point is not of great significance. The rarity of Dynastic documents referring to state irrigation management proves nothing. Even the Fayoum--whose centralized hydraulic management is undeniable due to the remains of massive water works--left no such records.

A similar point raised by Butzer concerns the absence of Old Kingdom titles denoting a centralized, bureaucrat responsible for coordinating irrigation-related actions at local and national levels (1976:110). It is possible that such a position is among the many untranslated titles of this period (Baer 1960).[9] It is also possible that the responsibilities of an irrigation overseer would simply be the seasonal duties of individuals working in another aspect of agriculture. As Sanders and Webster have written about hydraulic systems in general, "water-control functions are often embedded in political offices that have many other functions" (Sanders & Webster 1988:46). This seems a distinct possibility for what occurred in Dynastic Egypt given what is known about the extensive periods of seasonal unemployment for agricultural workers (David 1986:58; Kees 1961:55; Mendelssohn 1971). The point can also be made that there is a lack of known local irrigation official titles, but it would be a serious mistake to infer from this negative data that there were no local irrigation officials (see van den Boorn 1981:310-331).

Others differ with Butzer's conclusion and note that "the early district-governors of the Old Kingdom had as their chief title 'Digger of the Canals'" (Drower 1954:537). The basis of this title is most likely to be found its holder's ability to conscript labor for canal building and maintenance (Kees 1961:52). As pointed out by Harris, Butzer contradicts himself with the very evidence he presents to build his developmental chronology of irrigation.

> The mace head of the Scorpion King pictures a 3100 B.C. predynastic ruler either opening a levee or initiating construction of a canal. Butzer accepts this and other evidence as an indication that "artificial" irrigation including deliberate flooding and draining by sluice gates, and water contained by longitudinal and transverse dikes, was established by the 1st Dynasties." He also admits that the central government engaged in vast hydraulic projects beginning in the Middle Kingdom (2000 BC) aimed at regulating the level of the Fayum lake and at draining large portions of the Delta region, though he regards these monumental undertakings as exceptions and therefore insignificant for an understanding of dynastic political organization. (Harris 1977:242)

Why would a nation state organized around the rise and fall of the Nile's water's not coordinate the labor of it's subjects? The Dynastic agricultural cycle was controlled by the seasons; as the summer flood waters rose, dikes were shaped to hold back waters. Planting began after the waters receded, the harvest occurred a few months later. Later in the spring, the maintenance and construction of canals occurred. Because of the seasonally specific functions of each task, there would be no reason for the creation of a ministry exclusively devoted to irrigation as opposed to other facets of the agricultural process. One can just as easily ask Butzer about the absence of <u>local</u> irrigation officials. From this absence, Butzer does not likewise insinuate that the canals of Egypt were built and maintained without government assistance of any type.

Butzer downplays what others have called "the establishment of a national labor service composed of peasants in order to utilize labor at a time when agriculture was at a standstill"(Kees 1961:55). Not only was the Dynastic yearly cycle tied to the state's management of irrigation, but infringement's against the state's irrigation policies could lead to damnation in the afterlife. Kees notes that the 125th chapter of the Book of Dead address the seriousness of defying the agricultural laws of the state:

> It is certainly not by chance that in the New Kingdom among the sins from which the judge in the other world must absolve the dead before they can gain salvation are: lessening of the arable area, falsifying the boundaries of the arable land, '<u>damming up the water in his time,' illegal damming up (of basins) and selfish infringement of water-rights and land-rights to the injury of a neighbor</u>. (Kees 1961:57, emphasis added)

Another source of evidence supporting the Dynastic state's interventionist role in Egyptian irrigation is found in documents from periods of managerial collapse. The First Intermediate period's collapse of centralized government services resulted in nearly a century of political devolution. As a consequence of this

> the irrigation system, dependent upon centralized order and control, broke down, and famine and despair became commonplace. We are fortunate that a number of manuscripts have been discovered which describe events during this period, and provide a vivid picture of the horrors which afflicted the Egyptians. (David 1986:25-26)

David illustrates the dramatic effects of centralized collapse on daily life in this period by presenting a passage from the poem "Dispute with his Soul of One who is Tired of Life." In this passage the state's negligence has reached a point where basic agriculture is no longer possible:

> Nay, but the Nile is in flood, yet none plougheth for him.
> Every man saith: 'We know not what hath happened throughout the land.' (cited in David 1986:26)

It is interesting that when Butzer mentions this same genre of lamentation literature it is in the context of blaming "inflexible bureaucracy" for the collapse of the Old Kingdom (Butzer 1976:54-55).[10]

Summary and Conclusions

On the whole, Butzer's argument for a minimal state presence in Dynastic irrigation is quite weak, it is simply a theoretical proposition used to arrange a little data and a lot of supposition. Contrary to Butzer's claims there is a wealth of textual, architectural, archaeological and cross-cultural data which support a model of more interventionist Dynastic governments. What little demographic evidence does exist could just as well (but perhaps more parsimoniously) be explained by a more demographically driven hydraulically centralist model. Unfortunately, given the available demographic data, a demographic determinative model can explain Dynastic development only as well as Butzer's model can. On its own, a demographic explanation can do no better than Butzer's bureaucratic model, but with the inclusion of the vast amount of data from other societies, a hydraulic and demographic explanation gains a parsimonious advantage over Butzer's.

A wealth of cross-cultural data (both ancient and modern) demonstrate that population densities increase after periods of managerial collapse, not decrease as Butzer suggest for Egypt. Likewise, the general similarities between Egypt's hydraulic bureaucracy and those of other hydraulic states negates his claims of "no direct causal relationship between hydraulic agriculture and the development of the Pharaonic political structure" (1976:110).

I can appreciate the limits of the Egyptian data available to Butzer. If this were the only available information on the evolution of hydraulic states his hypothesis would be tenable. But there is also a wealth of cross-cultural information pertinent to hydraulic societies and demographic theories which Butzer chooses to ignore. In these terms Butzer has ignored more data than he has accounted for. Butzer himself negates the validity of such criticisms by declaring that he "doubt[s] that the Egyptian pattern elucidated [in Early Hydraulic Civilization in Egypt] is applicable to other irrigation civilizations" (Butzer 1976:111). Such ideographic considerations not only limit Butzer's inquiry into Egyptian prehistory, they also strip any hope of cross-cultural pattern recognition and the possibility of theory building that follows.

Before looking at the historical patterns of irrigation in the Fayoum we first examine the impact of conveyance loss on the development of irrigation societies.

Notes

1. I have written to Klaus Baer for a copy of this key unpublished paper, but have received no reply.

2. After a long passage on the absolute power of the Old Kingdom superstructure Butzer admits that some elements of the environment played <u>some</u> role in the evolution of Dynastic states.

> Pharaonic civilization remains inconceivable without its ecological determinants, but not by the linear causality model of stress --> irrigation --> managerial bureaucracy --> despotic control. (Butzer 1976:111)

3. In describing the urbanization of Near Eastern floodplains, Butzer does not mention the increase in population at the end of the Neolithic, but instead he only comments on the population growth following state formations.

> Agricultural colonization of the alluvial valleys of the Tigris-Euphrates and the Nile was followed by a rapidly increasing population and the development of an intensive cultural landscape. (Butzer 1971:602)

4. These sorts of political analysis are the bread and butter of defensive political pundants from all societies: Marxist analysts of the collapse of the Soviet Union blame the mismanagement and corruption on "bad" leaders and social pathos, not on the systemic lack of contingencies fostering concern with the system's management.

5. The newspapers of the last decade alone have been full of innumerable instances of this process of increased population pressure and as government's collapse (consider the famines of Ethiopia, the Sahel, and Somalia etc.). In modern terms we generally refer to these masses as "refugees."

6. This denial of the relationship between local and supra-regional organizations is similar to Hunt's refusal to recognize federal inputs in various "localized" irrigation projects.

7. Butzer rejects Sneh, Weissbrod and Perath's work because an "archaeological examination was not carried out" (Butzer 1976:46). One is left to ask Butzer where is the specific archaeological work that supports the dozens of generalized "demographic inferences" (1976:76) Butzer makes throughout Early Hydraulic Civilization in Egypt.

8. Compare Amenemmes' administration's regulation of each district's water with Butzer's assertion that,

> Competition for water was never an issue, except at the local level, since whatever was done in any one natural flood basin, it did not deprive the next basins downstream of their direct access to the Nile. (Butzer 1976:109)

9. Baer lists dozens of titles from the Middle Kingdom alone for which he had no translation. It is too early to discount the existence of irrigation ministers in dynastic times. Also see van den Boom 1988 for a discussion of the shortcomings of dynastic title lists.

10. Butzer believes that the Old Kingdom's inability to adapt to years of limited floods brought about Dynastic collapse (1976:54-55). This is an odd way of transforming an ecological disaster into a bureaucratic disaster.

CHAPTER 3
CONVEYANCE LOSS AND LOCAL SOCIETY

> The efficient running of the basin system depended entirely on a strong centralized government, for every upstream basin could endanger the riparian rights of those downstream. Gamal Hamdan 1913

The problem of the effects of irrigation on social structure and political economy encompasses more than the validity of Wittfogel's hydraulic theory. Regardless of whether an irrigation system is hydraulic or hydroagricultural, certain structural features may be expected to recur in relation to aspects of irrigation regimes. In this chapter, recurrent structural response to a feature known as "conveyance loss" will be examined.

Although not identified by Wittfogel, the structural effects of conveyance loss strengthens the general premise that underlies his insistence on the importance of specific features of irrigation systems for an understanding of domestic and political economies. In addition, consideration of the recurrence of phenomena associated with conveyance loss will further set the stage for our examination of the significance of irrigation in the Fayoum.

Gravity-Fed Irrigation and Conveyance Loss

"Conveyance loss" refers to the water that is lost as irrigation water travels from its source to the fields. The factors that lead to conveyance loss include, evaporation, evapotranspiration, seepage and spillage. The phenomena of conveyance loss in gravity-fed systems has implications for the evolution and structuring of societies reliant on the delivery of water for agriculture. During the past decade there has been an increasing realization that as a result of conveyance loss unlined gravity-fed irrigation systems favor irrigators whose plots are located toward the "top" of the canal network (Bromley et al. 1980; Moore 1980; Skold et al. 1984). The unequal access to water--if unchecked--leads to differential agricultural returns, that are translated into differential economic and social benefits for top-ended system members.

In both Hydraulic and Hydroagricultural societies, conveyance loss effects agricultural productivity. In societies which have private property, the effects of conveyance loss have a special importance. In irrigation societies without private property, conveyance loss effects the overall productivity of specific lands and the system as a whole, but it does not differentially reward individuals. The combination of conveyance loss and private property results in differential agricultural returns favoring up-canal irrigators who can convert this into personal gains.

There can now be no doubt that conveyance loss seriously diminishes agricultural returns. There are countless statements testifying to this condition:

> Farmers whose fields are most distant from the source of water frequently have the least secure water supplies. Their greater water insecurity is related to (1) the greater cumulative effect of seepage and evaporation losses in delivery channels as fields are more distant for the water source, and (2) the greater possibility for intervening irrigators to disturb intended water distribution as the water flows from head-end to tail-end fields. (Bromley et al. 1980:371)

or:

> For two reasons "top-enders" almost always obtain more water per unit of land than "tail-enders", and thus enjoy more success in their cultivation. The first reason is that the volume and pressure of water in irrigation channels is greater at the top ends. Even without human interference, the harsh facts of hydraulics favor "top-enders". The second and related reason is that it is physically much easier for "top-enders" rather than "tail-enders" to poach or steal from the irrigation channels more than their allotted share of water. . . . Unequal access to irrigation water is the single cause of socioeconomic inequality between top-enders and tail-enders. (Moore 1980:3; as quoted in Pfaffenberger 1990:368)

Agronomists and social scientists alike have "talked around" issues of conveyance loss and its impact on cultural evolution. They mainly discuss these inequities in terms of "development policy planning" and "effectiveness of system design," neglecting the significance of conveyance loss for cultural evolutionary processes. Some recognize the effects of the system's functional short comings on production and planning:

> It does little good to be taught proper water-application procedures when the water never reaches your farm, or arrives so sporadically that planning is impossible. (Bromley et al. 1980:384)

A variety of cross-cultural sources demonstrate that top-ended farmers have advantages over their down-canal neighbors. In Peru's Colca Valley irrigation system farmers whose lands were closest to canal offtakes have advantages over distant irrigators.

> The location of terraces within a sector is a very important determinant of the relative quality of water that will be available to them; those closest to the head will be irrigated first and those in the tail last. This becomes very important when a sector has insufficient water and must stretch out the [allowed length of time] beyond an ideal 90 day cycle. (Guillet 1987:413)

Likewise among the Taita of interior Kenya the irrigation cycle is traditionally organized so that those closest to the water intake irrigate first (Fleuret 1985:111). The amount of water that farmers receive roughly co-varies with the size of their land, but no attempt at all is made to compensate for conveyance loss. The economic and social effects of this rotation and distribution system are far reaching. In fact,

> When water is scarce, the fields of those at the ends of the system are irrigated inadequately, if at all. It will be seen that <u>farmers at the physical periphery of the system are also of peripheral social status</u>. (Fleuret 1985:111 emphasis added)

This demonstrates the infrastructural effects of conveyance loss on social formation, though Fleuret himself overlooked the implications of his own data and concluded that "water relations" are "epiphenomena of social relations" (1985:113). This would perhaps be a defensible point of the Taita situation were an idiosyncratic one, but it is one repeated throughout the world among irrigators.[1]

Corrective measures to compensate irrigators located at a distance from the water sources have evolved in many cultures. These measures are attempts to compensate irrigators for the effects of conveyance loss by allotting distant irrigators additional irrigation time to compensate for lost water. The type of corrective measure taken is partly a function of the method used in measuring the water, and partly a function of the culture's overall reliance on irrigation agriculture. The effectiveness of these measures in part determines the degree of stratification of the society.

There are instances of non-state societies that only partially rely on irrigation agriculture and appear to carry over their minimally stratified practices to the matter of water distribution. In the northern Philippines, the dry season terraced farming among the Kalinga uses a system of water shares and measurement known as tobtobwak.[2] The Kalinga engage in irrigation agriculture only seasonally, the majority of their subsistence (in terms of time-spent) comes from swidden agriculture. At the beginning of the dry farming season, a council meeting is held and a daily irrigation schedule is agreed upon.

> The first day water is parceled to the owners of fields in one area. These owners get together to decide how to apportion the water for the 24-hour period. If during the 24-hour period, water has not reached a certain field, the owner must persuade his neighbors to

> let him have some. Usually the water is started with the field farthest from the source. (Lawless 1977:46 emphasis added)

Given what we know about conveyance loss's impact on productivity, it is reasonable to interpret this (ethnographically rare) decision to first serve distant irrigators as an extension of the their overall egalitarian approach to property and production.[3]

Problems of Water Access and Distribution

Clearly Wittfogel's distinction between hydroagricultural and hydraulic society, and the importance he attached to different levels of hydraulic density, indicates that he was concerned with specifying the formative elements of each irrigation system. Though Wittfogel regarded the exact type of water supply as a key variable, he did not really explore the evolutionary implications of non-expansive gravity-fed irrigation systems.

All gravity-fed systems have specific managerial problems that must be addressed. Gravity-fed irrigation systems operate under three basic principles of administration (Bromley et al. 1980:374). These involve the principles of operation, maintenance and enforcement of water use policies. Whatever level of irrigation authority is present must develop methods of dealing with each of these issues.

All irrigation systems have rules governing water use, and the responsibilities of irrigators. These rules can include allocation formulas, rotation cycles, and preemptive irrigation rights. There is of course a great variation in the degree to which these rules are actually followed. Some form of water theft can be assumed to be common in irrigation systems around the world to one degree or another.

The enforcement of rules governing the operation of gravity-fed irrigation systems require some type of overseeing organization. This can take the form of something as small as a lineage based community based council, an ad hoc committee that arbitrate complaints, a local irrigation cooperative, or an organization as large as a state Ministry of Irrigation.

All gravitation-fed irrigation systems require some level of maintenance and repair. The more complex and extensive the system, the greater the need for coordination of maintenance and repairs, otherwise individuals would only maintain irrigation works pertinent to the operation of irrigation in their immediate area and ignore repairs that do not directly pertain to them.

Gravity fed irrigation systems most commonly operate under rotating schedules of water use. Some dictate that the same farmers (or plots) must irrigate at the same time every week (or other time cycle, e.g. Egyptian Fayoum), while others dictate only a fixed order that operates independent of other schedules (e.g. Yemen, Sri Lanka, or Taiwan).

Because gravity irrigation water is universally a limited commodity, some method of water allocation is necessary in gravity-fed irrigation systems. Different methods of allocation are used by different cultures. In his study of the development of irrigation in medieval Valencia, Glick differentiated between the "Syrian" and "Yemeni" allocation methods.

In the Syrian method, "the total debit of the river or spring was divided among the principal canals taking water from it, in proportion to the amount of land served by each canal"(Glick 1970:207). The "Yemeni" method of allocation measured water in units of time that were not proportional to the size of land units. As Varisco has shown, Glick's choice of nomenclature for these two allocation methods does not accurately represent a diffusion of methods (from either Yemen or Syria), though the actual differences in measurement methods is of itself an important distinction (Varisco 1982:26-33).

Individuals in gravity fed irrigation systems universally attempt to measure, and regulate the amount of irrigation water used. This most commonly occurs with the institution of water-shares. Water-shares are set volumes of water allocated for specific volumes of land. The volume of a water-share can be measured by either time (as in Fayoum) or volume (as in Yemen where cisterns are filled during the night and discharged during the day see Varisco 1982).

All societies that rely on gravity-fed irrigation have some authority that governs water allocation. This can take the form of a pre-existing general village council (Bolin 1990; Conklin 1980; Lawless 1977), or specifically created irrigation councils which may or may not have the backing of a larger state structure (Biswas 1970; Lees 1986; Mehanna et al. 1984; Smith 1989).

Below, the infrastructural conditions in Yemen, Bali, and Sri Lanka are used to illustrate the effects of conveyance loss in specific hydro-agricultural systems.

Yemen and Conveyance Loss

The traditional irrigation systems of the Yemen's Serat Mountains provide an excellent example of the effects of conveyance loss in a hydroagricultural society. In Yemen, the countryside is divided into four distinct ecozones. The Tihamma coastal plane has sparse rain-fed irrigation a few months out of the year and during the rest of the year no agriculture is possible.

The Serat Mountains run along the Red Sea coastline, reaching elevations above 13,000 feet. Along the upper elevations are Yemeni villages with locally managed spring-fed irrigation systems separated by high valley systems.

The high mountainous plain running along the top of the mountains is also dominated by small spring-fed irrigation systems. The interior of Yemen borders the edge of the Empty Quarter. Few springs feed this side of the mountains, and what agriculture exists is supported by the summer monsoon rains.

In Yemen, the isolated geography of mountainside villages guaranteed the failure of all past attempts of the state or regionalized attempts to organize irrigation. Yemen's medieval history provides a number of examples of unsuccessful attempts to control inter-valley regions under a centralized confederation (see Douglas 1987). The geographical isolation and hydroagricultural system of Yemen developed some social forms similar to those in other small scale irrigation societies. For instance, there has been a general trend away from centralized governmental interference in all forms of Yemeni village life. Isolated villages have been the rule and "tribally" (village-lineage based) organized society has been the norm for the past few thousand years, the efforts of Armenian, Ottoman, British, and Soviet states notwithstanding. The attempts of past regimes to employ despotic rule have all ended in failure, largely because this is an ecological system unable to support the formation and sustenance of a despotic state. The geographical isolation has always favored the efficiency of locally organized networks of tribal rule. In Yemen, when past highland states have attempted to extend themselves beyond the capital cities of Sanna or Sadda, they have done so with little impact on the majority of the tribal countryside. Yemen is an excellent example of how a mountainous ecological setting has historically constricted the development of an effective centralized government (Douglas 1987; Meissner 1986; Messick 1978).

The goal of the Yemeni ghayl irrigation system is to allocate equal shares of water to all farmers holding water rights, but it is clear that a number of factors necessitate that disproportionate shares of water be received throughout the system. Among the rules of the traditional Yemeni ghayl system are, a) water from a spring must be shared equally by all irrigators in a system; b) fields nearest to the water source must be irrigated first (al Mutahib 1202 cited in Varisco 1982); c) water is generally to be measured at the source (and simple ditch-canals are used) (Varisco 1982:55). Because water is measured at the source (in cisterns), and then travels through unlined ditches, it has been recognized that some element of water loss occurs in transit from source to destination (Varisco 1982:279), and this must logically be a significant factor for plots at a great distance from the source. Clearly the plots closest to the water source have a greater access to water and thus stand to be the most productive and valuable.

In the Yemeni highland spring charged cistern system, the measurement of water is taken at the point of destination out of recognition of water loss. Thus farmers at a greater distance are not as penalized as they would be if water were measured at the cistern. But despite attempts to compensate distant irrigators, the over all "unreliable water receipts by farmers have a significant chilling effect on the adoption of new agricultural methods--including the so-called Green Revolution technologies" (Bromley et al. 1980:366).

> Inequities arise because "loose" operation of the system allows water "stealing" infrequent or improper maintenance of distributaries, or simply results in unreliable water deliveries to those less advantageously situated on the project. Often, more powerful farmers exert inordinate influence over water-management decisions. (Bromley et al. 1980:368)

The Yemeni ghayl systems actually developed a sort of "anti-trust" rule (shuf'a) out of recognition that the top fields were the most productive. The Islamic principle of shuf'a may have functioned in the past to diminish inequalities in land productivity from the top to the bottom of terrace systems. Shuf'a is a principle of "pre-emptive rights" that gives the nearest downstream neighbor the primary option to buy a plot of land which is for sale (al Murtadaa 1392). Shuf'a has been interpreted as functioning to consolidate land holdings acquired through inheritance (Varisco 1982:247), or as a structural mechanism promoting the independence of regional groups (Milliot 1953:591). If shuf'a only specified that nearest neighbors must first be consulted before property could be sold, then these would be adequate explanations. But these explanations do not account for the directional nature of shuf'a, which allows mobility in a specific upstream direction, towards the water source. Shuf'a may have functionally weakened longtime economic inequalities that were the inevitable outcome of using the Yemeni ghayl irrigation system by encouraging economic mobility for those at the bottom of the system, while at the same time creating obstacles against attempts by those at the top to buy them out.

Bali and Consequences of Bali High and Subservience: The Power of Bali Low

Clifford Geertz description of Balinese irrigation society makes clear that Bali is a hydroagricultural society, not a Hydraulic society as Wittfogel had claimed.[4] Regional temples manage irrigation works along the confines of water-ways that limit their expansion of power. For the priestly managers of these systems, the power over irrigation is as limited as the specific water course they manage, their power does not reach to non-contiguous water networks. Geertz describes this regional management system as one in which,

> irrigation was in the hands of a separate, also local, corporate body, of which there were hundreds over the countryside; and rather than leading to the development of a centralized bureaucracy to manage waterworks this system effectively precluded the emergence of such a bureaucracy. (Geertz 1973:335)

A recent study of Balinese irrigation by Stephen Lansing provides further evidence of the hydroagricultural (as opposed to hydraulic) nature of this system, as well as some cultural effects of conveyance loss (Lansing 1991). Lansing's analysis of the Bali's water temple system is primarily concerned with the symbolic role of these temples, but he does mention "the hydro-logic of upstream and downstream dependency" (Lansing 1991:55). Lansing's approach to irrigation is steeped in the logic of Sahlins' cultural model where cultural logic is above the dictates of material conditions.[5]

Lansing establishes the presence of symbolic relationships between upstream and downstream temples that are best understood in light of what is known about the material consequences of conveyance loss. The symbolic powers of irrigation water are transformed as the water passes downstream from one temple to the next, upstream temple water has "lifegiving powers" while downstream is only "cleansing water--water used to purify, to wash away pollution" (Lansing 1991:54).

Lansing considers these two levels of function to have equal levels of symbolic power.

> Whereas the waters high above in the crater lake represent the mystery of water as life-giver, the waters of the sea are associated with the equally potent mysteries of dissolution and regeneration. (1991:54-55)

But I am not satisfied that this representation of spiritual equity is warranted from what is known about other uses of these waters. There are hints of a sort of riparian hierarchy of waters' spiritual essence. For example, downstream water is "not collected in sacred vessels, like upstream water" (1991:54).

In fact, Lansing recognizes a riparian symbolic structure based on the principle that:

> The particular potence attributed to different varieties of holy water are symbolically associated with the original source of the water. Holy water must originate from an upstream source, and in most instances the more upstream a source is, the more potent the holy water that can be made from it. (Lansing 1991:55, emphasis added)

According to Lansing, the divine priest-ruler (Jero Gde) of the upstream Crater Lake temples (and those geographically below it) has an authority defined by the irrigation works located in his irrigation system. More specifically, his power is defined by his upstream location in this irrigation system. Lansing does not consider the possibility that top-ended rulers did not expand their realm of control beyond the water systems below them because of the geographical limits of this non-expansive irrigation system. Instead, he simply concludes that:

> The symbolic systems that invest the Jero Gde with authority originate in the internal logic of the water temple system. Wider claims to temporal and sacred power--true kingship--would not be extensions of this logic but claims of a different order. (Lansing 1991:93)

Nonetheless, the limits of the Jero Gde's temporal power are clearly reflected in the limits of the water that flow from his temple. Lansing, sidetracked by the functionality of Balinese "internal logic", misses the external logic dictating that a water based ruler will have difficulty ruling beyond the domain of his water! Of course the structures of this hydro-agricultural society are bound and codified in Balinese superstructure, but it cannot be argued that this factor determines the size and scope of hydraulic systems.

Sri Lanka and Conveyance Loss

Bryan Pfaffenberger questions both the premises of Wittfogel's Hydraulic Society theory and the claims (made by Moore and others) that gravity-fed irrigation systems are inherently conducive to social inequality as a consequence of conveyance loss. Pfaffenberger explicitly critiques the technological determinist model of irrigation and society. In one passage he summarizes a portion of the technological determinist paradigm and then rejects it outright:

> For Third World critics of Western technology, the differentiating effects of gravity-flow irrigation schemes and Green Revolution technology amount to a Trojan horse: a Third World country imports Western technology to improve social welfare on an equitable basis, only to find that the technology insidiously reproduces the class structure and class relations of capitalism. . . .The critics of gravityflow irrigation schemes sketch a plausible portrait in accord with technological determinism, the doctrine that deems the effects of a technology to be so rooted in the imperatives of nature that they lie beyond the control of human choice and values. . .This article argues, however, that the supposed causal relationship between

> gravity-flow irrigation works and socioeconomic differentiation is, in the Sri Lankan case, illusory and deceptive. The appearance is created, and becomes convincing, only to the extent that observers adopt a highly restricted definition of technology, a definition that includes only the hardware of irrigation (such as dams, pumps, and canals). (Pfaffenberger 1990:363 emphasis added)

Again, Pfaffenberger rejects the technological determinist position that he so eloquently describes.

Pfaffenberger uses historical and contemporary data from Sri Lanka to argue that indigenous structural and superstructural controls have overridden (and continue to over-ride) any order materially imposed by the acquiring of new technologies or productive systems. Yet at the same time he does not dispute that the result of recent irrigation developments in Sri Lanka has been exactly that of reproducing the above cited class structure and class relations of capitalism. He is familiar with arguments that Sri Lanka's system inherently favor's farmers at the top of the system.

Pfaffenberger rejects theories of ecological or technological determinism. He believes it is deceptive to suppose a "causal relationship between gravity-flow irrigation works and socioeconomic differentiation" such as is described by Moore (Pfaffenberger 1990:364). For Pfaffenberger, the impression that technology and the environment have created these conditions is only an illusion.

> As scholars in the history of technology frequently argue, <u>a more useful definition of technology would certainly include cultural values</u> and social behaviors, which are, after all vital to the operation and maintenance of a technical system. (Pfaffenberger 1990:364, emphasis added)

A definition of technology that effaces the distinction between material and ideological social life has zero analytical utility. As a general principle, all-inclusive definitions greatly reduce the possibility of discussing the specific dynamics of a given system: if everything is technology, then what is there left to talk about?[6]

Pfaffenberger does not deny that the "material" technology (as opposed to his mental technology) of the Sri Lankan system is prone to favor "peasants at the top end [who] receive water more regularly and in greater amounts than the peasants at the tail end" (Pfaffenberger 1990:362). His point is that unless the social rules governing the system of water rights and land rights are also considered as <u>determining</u> features of the system, then a mechanical, misleading interpretation will follow. For him there is an opposition between the goals of the material and mental technological forces. In his view,

> Sri Lanka's modern irrigation technology, then does not <u>cause</u> socioeconomic differentiation. Rather it does little or nothing to stop an <u>existing</u> differentiation process, which intrudes from the schemes' environment and subverts their social and economic objective. (Pfaffenberger 1990:395)

One might as well argue that capitalism does not <u>cause</u> inequality or class, only that inequality and classes are to be found in capitalist economies without enough surplus for all society members to share equally. Such reasoning reduces universals to anomalies without having to examine cause and effect: No capitalist could ever have enough surplus for all to share equally and likewise irrigation technology causes socioeconomic differentiation.

While Pfaffenberger assures us that irrigation technology "does not cause socioeconomic differentiation", he does not offer any satisfying explanation of his own for the top heavy state of inequality in Sri Lanka.[7] Moreover Pfaffenberger does not attempt to offer examples of hydroagricultural gravity-fed irrigation systems that did not develop socioeconomic differentiation. Nor does he address the extent to which these patterns of inequality have developed cross-culturally. The widespread evolution of similar "differentiation processes" among societies around the world that share similar ecological and technological environments suggests that infrastructural components do more than maintain otherwise unexplained pre-existing cultural preferences for "socioeconomic differentiation" (Pfaffenberger 1990).

Pfaffenberger could easily un-muddle a portion of his argument by instead saying that the technology of Sri Lankan dry irrigation inherently favors top-end irrigators, though some cultural practices have existed that attempted to compensate for this infrastructurally determined inequity.

But this alone would not address issues pertaining to the factors determining the adoption of particular social regulations.

Finally, Pfaffenberger offers no evidence to demonstrate that a more equitable distribution ever existed in Sri Lanka's monastic past. He does refer to epigraphical and literary sources suggesting the presence of "strong norms of equity in the distribution of water", but these sources only provide information pertinent to the self proclaimed spirit, not the practices of the times (1990:372).

Sri Lanka (like most non-riverine irrigation systems) is a non-expansive irrigation system (Uphoff 1990). There is nothing to be gained by its governing powers through the imposition of a centralized state-run irrigation system. The geography of Sri Lanka dooms all such attempts to failure. There are no hydraulic resources that could be intensified or expanded beyond the local networks. Any administration that attempted to run irrigation works from a centralized base would be wasting its time and energy. These communities are independent entities that would bankrupt the coffers of a centralized state if it undertook the expenditures required for any type of massive despotic interdiction.

Summary and Conclusions

In combining the points of this chapter with those of the first chapter, we find the theory that irrigation has been a causal force in the evolution of political economies continues to be supported by a considerable amount of empirical evidence. The consequences of irrigation however are not monolithic or unilinear but vary in two main respects: 1) the administrative organization needed to fulfill the productive potential of large-scale riverine systems; and 2) the development of institutions that compensate for or regulate inequalities that arise from conveyance loss at the local level, no matter how large or small the system may be. Put in the form of hypotheses these perspectives may be stated as 1) When the distinction between hydroagricultural and hydraulic systems is not neglected, irrigation accounts for many aspects of political economy; and 2) conveyance loss generally results in distinctions of rank among the users of gravity-fed systems despite ideological intentions and rules favoring egalitarian solutions. As we will see in the chapters that follow, conveyance loss also reveals much about the limits of centralized states to manage all aspects of irrigation.

The phenomenon of conveyance loss presents us with an (largely over-looked) example of a culture's ecological and technological setting (infrastructure) influencing the evolution of social structure. Despite cultural efforts to compensate down-canal irrigators, conveyance loss favors up-canal irrigators in most societies. Even in societies with highly centralized irrigation systems, conveyance loss influences the agricultural returns of individuals--illustrating again the difference between centralized states and the sort of omnipotent states that Wittfogel's critics seem to insist on.

The physical realities--environmental and technological--of gravity-fed irrigation necessarily create unequal access to water. The joined forces of conveyance loss, transpiration, and evaporation combine to favor some fields, and some farmers over others. Unequal access to water results in differential economic returns, which in turn influence the formation of the social order at a village level.

In the next six chapters the hydraulic history of the Fayoum is outlined, paying particular attention to the continuous importance of a centralized state for any degree of agricultural success. The Fayoum's agricultural/hydraulic history is also shown to reveal particular relationships between up-canal and down-canal neighbors and communities.

Notes

1. Western anthropologists, and other social scientists are not alone in ignoring the forces inherent in irrigation societies. One of the greatest works of American fiction skirted issues of hydraulic society while pursuing plot lines dependent on its waters. Steinbeck's Grapes of Wrath is a case in point. The Joads are simply the victims of capitalism, rather than the historical hydraulic

orchestrations which created their predicament. Compare the following two critiques of Steinbeck's work by the late novelist John Gardner and ecological historian Donald Worster. One critique is based on the internal literary truths of the novel, while the other is based on its external sociological standing. Gardner writes that,

> [the Grapes of Wrath] should have been one of America's great books. But while Steinbeck knew all there was to know about Okies and the countless sorrows of their move to California to find work, he knew nothing about the California ranchers who employed and exploited them; he had no clue to, or interest in their reasons for behaving as they did; and the result is that Steinbeck wrote not a great firm novel but a disappointing melodrama in which complex good is pitted against unmitigated, unbelievable evil". (Gardner 1983:10)

Compare this with Worster:

> Nowhere in The Grapes of Wrath does Steinbeck draw attention to the elaborate hydraulic apparatus that has been required to create the California garden. In fact, the process of irrigation does not even appear in the text. Grapes, carrots, cotton and the like are the products, it would seem, of spontaneous nature, not the contrivances of advanced water engineering and the social organization it has required. (Worster 1985:229)

Both Gardner and Worster complain that The Grapes of Wrath falls short of being a great novel for not looking far enough into the forces responsible for victimizing the Joads and the other itinerant farmers. There is a sense that Steinbeck "quit early" in his analysis: Steinbeck portrayed symptoms rather than causes. Even in the most epistemologically revealing chapter (chapter 21), he stops short of identifying the ultimate hydraulic causes of the Joad's situation.

Literature does also contain examples of authors building plots hinging on hydraulic issues such as water-theft and conveyance loss. In John Nichol's novel The Milagro Beanfield War a community's order is unraveled by one man's unauthorized procurement of irrigation water. Marcel Pagnol's novel and Claude Berri's films Jean de Florette and Manon of the Spring concocts a web of murder and deceit spanning generation, all over the theft of water by down-hill neighbors. Roman Polanski's Chinatown is similarly a tale of murder and intrigue based on the pressures of up-canal water theft.

2. The general features of this method are not confined to the Kalinga. Lawless notes similarities between this system and the neighboring Bontoc (Lawless 1977:46).

3. It would be interesting to know if other northern Philippine groups who are more reliant on irrigation farming also start measuring water at distant plots rather than ones near water sources.

4. This is an instance of Wittfogel failing to follow his own research design and adhere to the definitions of hydro-agricultural society rather than a negation of Wittfogel's hydraulic theory. Geertz is correct to fault Wittfogel for having "been incautious enough to quote Bali in support of his arguments" for the hydraulic state (Geertz 1973:338). Wittfogel misdiagnosed Bali as a hydraulic society by not recognizing the non-expansive nature of the hydraulic resources. Lansing's description of Balinese irrigation being "centrally organized by a system of water temples, separate from the state" fits this picture of a hydroagricultural society where regional temples oversee local irrigation practices (Lansing 1987:338).

5. Lansing's approach disarticulates the symbolic process of Balinese irrigation from the material world it is embedded in, the symbolic process somehow becomes both causes and effects.

6. Not to mention that a definition of technology which includes ideology would render Pfaffenberger himself to be a dreaded technological determinist.

7. All of this raises questions about the historical-economic impact of gravity-fed irrigation on the development of caste in Sri Lanka. But these are not questions of interest to Pfaffenberger. Other writers have hinted at the possibility of such a relationship, for example Ryan wrote,

> Regionally the castes are scattered in almost a haphazard manner, but within the local settlement, residence is much less chaotic. The local community, almost invariably has some, and usually <u>a high degree of ecological segregation</u>. (Ryan 1953:202, emphasis added)

Further research is required to determine if a relationship exists (or existed in the past) between land holdings by caste and access to irrigation water.

CHAPTER 4
HYDRO-ECOLOGY AND THE FAYOUM: THE NATURAL AND PRE-HISTORY

> Population pressure, the obverse of carrying capacity, must accordingly be defined not in terms of absolute size or density, but in terms of increasing energetic costs and diminished returns involved in sustaining a given way of life.
> ---Barbara Price

Geological and Ecological Foundation

The geological and ecological formation of the Fayoum Depression and Oasis is an ongoing process of natural (and at times cultural) processes that began over a hundred million years ago. The general features of the Nile Valley drainage system were formed during the Miocene from a widespread process of northern and western uplift (Abu al-izz 1971:40; Ball 1927; al-Baz 1984; Bornkamn et al. 1989; King 1925). The Miocene sea level was 180 meters above current levels which transformed the Nile Valley "into an elongated estuary" (Abu al-izz 1971:44). The Fayoum during this period underwent episodes of uplift.

Processes of geological uplift began during the Oligocene and Miocene epochs that would create structural surfaces which eventually would weather away to form the Fayoum Depression. During the next millions of years winds carved out the unstable surface surrounding the up-lift zone until the depression was formed. Much of the wind erosion has occurred recently, during the Quaternary Period.[1]

The modern Fayoum depression is 12,000 km2 and drops from 30 meters above to 45 meters below sea level. Its formation is geologically similar to other depressions of Egypt's Western Desert. The Siwa Oasis in the Qatara Depression, the Kharagha and the Wadi Natrun depressions were formed by wind degradation approximately two million years ago during the pleistocene (Abu al-izz 1971; Brookes 1989). Each depression lies at varying elevations below the surrounding desert plane and slopes from east to west, some dropping to below sea level. These desert depressions tend to have gradually sloping southern edges with steep cliffs to the north. Each of these Oases has natural springs that allow agricultural production independent from the rising and falling waters of the Nile, but the Fayoum is distinct from all other oases in that it has always enjoyed some degree of free intercourse with the Nile's fertile waters.

Pfannenstiel recognized that all the depressions of the Western Desert are located at, on, or adjacent to radical geological boundaries (Pfannenstiel 1953; Abu al izz 1971:189). The Kharaga/Dakhla depression is formed where Nubian sandstone, Cretaceous mud and Paleocene chalks meet. The Bahariya/Farafra Depression is formed where Cretaceous and Eocene formations are exposed. The Qattara/Siwa Depressions are formed where Eocene depositions intersect with Miocene formations. The Fayoum Depression is located where Oligocene and Miocene formations meet (Abu al-izz 1971:190-191).

The Fayoum depression has experienced three major lake episodes: The Paleomoeris, Epimoeris and Lake Qarun (Gardiner 1943). Readings of lake-level curves from Ethiopia and Central Africa indicate that the formation of the Fayoum's lake epochs correspond with the other lake formation processes in the Eastern Sahara region. These similarities "may indicate that local rainfall was the most important factor in the feeding of the Fayoum lakes, which is also suggested by sedimentological studies there" (Schild 1987:23 cf. Butzer 1975a & 1975b; Caton-Thompson et al. 1937; Gardner 1926).

Today, a small range of hills located along the eastern edge of the Fayoum separates the depression from the Nile Valley. A gap in this range near al-Lahun and Hawara allows Nile water via the canal known as Bahr Yusef to flow into the Fayoum. In 1934, the Geological Survey of Egypt sunk several bore holes at Hawara to determine the depth of the bedrock and sediments at the point where the Nile Valley meets the Fayoum, it was found that the bedrock base was at a -17 meters elevation, thus establishing that the depression was caused by wind deflation rather than fluvitatile action as had previously been supposed (Little 1936; Issawi 1976:160; Apostolides 1967).

The springs that reach the Fayoum are charged and function like other springs of the Western Desert. These below sea level depressions allow waters held in surrounding formations to be discharged by a combination of weight and gravitational force. Waters work their way to the (low elevation) surface along the weak seams of the geological boundaries and faults.

Dozens of natural springs surface throughout the Fayoum, but the bulk of the oasis' water comes from the Nile via the Yusef Canal (Bahr Yusef). Some water also enters the Fayoum via the Wasif Channel that leaves Bahr Yusef south of the Lahun Gap (see abu al-izz 1971:171; Azadian 1928, 1930, 1931 & 1932; Whitehouse 1985). Bahr Yusef is the modern, reworked version of a natural water way that has connected the Fayoum with the Nile Valley system since the Paleolithic.

Ball established an Early Pleistocene date for the depression's wind-blown origins. At this time the Fayoum was wholly separate from the Nile Valley. During the Early Paleolithic, Nile waters first entered the Fayoum near Hawara/ al-Lahun leaving trace gravels and beaches at the 42 and 44 meter levels (Hug 1926, 1927 & 1929; Hume 1912; Issawi 1976:160 Pochan 1936; Said 1962).

In the past, the Yusef Canal flowed to the Fayoum directly from the Nile River, but since the time of the Khedives, (a century ago) its flow comes from the Bahr Yusef canal (Audebeau 1930; Ball 1930; Brown 1892; Caton-Thompson et al 1934; Keldani 1941). The Bahr Yusef canal branches off of the Ibrahimia canal about 250 kilometers to the south near the town of Dairut. The Ibrahimia canal branches off from the Nile at a point 100 kilometers further south from Dairut at the town of Asyut. The water from the Canal is used to irrigate the depression, and for drinking and household purposes. Water originating from Bahr Yusef eventually drains down to Lake Qarun on the western edge of the depression. Lake Qarun currently is about 214 sq km (at -45 meters elevation) and has a salinity level of about 3% due to the lack of any out draining waterway. At the beginning of this century its waters were brackish but potable (cf. Field 1953:388; Murray 1935:120) In 1971 abu al-izz wrote:

> We know that 365 million cu. m. of water reach the lake annually. This means that an amount equivalent to that is lost by evaporation or by outward seepage. (abu al-izz 1971:169)

The waters that have flowed into the Fayoum Depression have brought with them massive quantities of rich Nilotic silt, most of which is of class III quality (abu al-izz 1971:168; el-Quosy & el-Guindi 1981:8). Thousands of years of fluviatile deposition and the quantity of available water has made the Fayoum one of the most agriculturally productive areas in Egypt, and certainly it has the richest soils of any of the oases. Soils are for the most part only moderately saline, though the closer one moves toward Lake

Qarun the greater the salinity. Those soils located directly near the lake are often severely saline (el-Quosy & el-Guindi 1981; Said 1981, 1971a & 1972b). When given enough water, the Fayoum's soils have been shown to be among the most productive on Earth. But a constant <u>access</u> to water has always been the primary agricultural problem of the Fayoum.

The rich soils of the Fayoum and along the Nile Valley were formed by deposition processes that had occurred for thousands of years (Lucas 1902). Most of the silts are volcanic and contain potassium, nitrogen and other organic materials (Waterbury 1979:130; Willcocks 1904). Waterbury estimates an average of "110 million tons [of sediments were] moved by the river annually, 40 is silt, 30 percent fine sand, and 30 percent clay" (Waterbury 1979:129). Of course today the Aswan Dam prevents most of these minerals from being deposited in soils with the irrigation water.

Water has always been the limiting factor of cultural evolution for Fayoum populations. The drylands surrounding the Fayoum are classified as run-off desert and, if enough water were available, these lands could be as agriculturally productive as the Nile Valley (Abu al'izz 1971:168-180). The sparse plant life that does subsist recovers water in wadis and channels that mark the desert. Run-off deserts are distinct from other desert environments in their ability to nurture plant life in their gullies when the waters of infrequent precipitation reach the dry earth.[2]

Paleolithic/Neolithic Fayoum: Pre-State Background

During the Neolithic, the Fayoum's human populations expanded to their greatest numbers and habitation distribution for the pre-state period. The late Paleolithic and Neolithic transition in the Fayoum show the productive limits that the region can support without relying on irrigation agriculture.

Climatological changes during the Upper Paleolithic led to increased population pressure throughout Egypt, particularly in the now desert regions west of the Nile (Wendorf et al. 1980; Williams et al. 1980). Even in the Neolithic Period, water was the key environmental feature that defined the organization and limits of human populations of the Fayoum. As desertification intensified in the areas surrounding the Fayoum, the water collecting in the Fayoum Depression drew groups of peoples from surrounding areas to settle in the region. During Egypt's Paleolithic period, human populations lived as hunter-gatherers in the vast savannah environment of the region that is today the Libyan Desert. Between 50,000 and 30,000 years ago, North Africa experienced temperature fluctuations and decreased levels of rainfall. These climatological shifts lead to the widespread desertification of this region (Butzer 1976:13). Paleolithic artifacts are strewn in the

Western Desert surrounding the Fayoum providing the only traces of the human populations that exploited this savannah environment.

Between 25,000 and 17,000 years ago an arid tropical climate similar to today's began to stabilize in Northeast Africa (Butzer 1976:13). As levels of desertification increased, populations moved closer to the fertile Nile region, and to the area around the lake in the Fayoum depression. The flood plane of the Nile Valley at that time was roughly twice that of the present valley (Butzer 1976:13), and there is evidence that the levels of Lake Qarun covered most of what is now the Fayoum basin.

Between 17,000 and 8,000 B. P. there were more frequent winter rains, followed by corresponding higher Nile floods during summer months (Butzer 1976:13). At the end of the Wurmian Ice Age, there were increased levels of precipitation throughout Egypt (from 9000 to 6000 BC), and it was not until around 2350 B.C. that current levels of aridity were reached (Butzer 1971:584).

Paleoenviromental data record a number of changes in Lake Qarun levels and the desert grasslands occurred during the last ten thousand years (Close 1987; Connor & Marks 1986; Cohen 1977). Around 8,000 B. P. the Eastern Saharan climate became wetter, allowing for rehabitation of the bordering Saharan regions by peoples from the Nile Valley (Wenke et al. 1988:32; Hassan 1980a & 1980b). Water flowed unrestricted from the Nile into Lake Qarun, and lake levels fluctuated with the yearly rising and falling of the Nile. For the Fayoum (and probably the development of all agriculture in Egypt), the most important environmental change occurred between 7,000 and 6,500 B.P (5,000 - 4,500 B.C.) and resulted in Lake Qarun dropping to such low levels that it may have dried up completely (Wenke et al. 1988; Hassan 1986b:70; Close 1984). The causes of the lowering lake level are not fully understood, but the extent of the decreased water levels is evident throughout the lower Nile's basin.

Corresponding with the termination of the lowest lake levels is the appearance of the first known sedentary agricultural communities in Egypt and the Fayoum. The evidence of these communities has been found in the sites of Merimda Beni Salama in the Delta, and on lands surrounding the modern Fayoum Oasis.

The Fayoum was a geographical cul de sac along the Nile that must have absorbed population overflows as population pressure increased along the Nile (Hassan 1984; Hayes 1975 cf. McBurney 1967). The Fayoum's Neolithic peoples lived in small groups and subsisted primarily on the aquatic, mammal and plant life they captured from and around Lake Qarun. There are many unanswered questions surrounding the lifestyle of these peoples. Though (probable) Neolithic food bins have been found, no neolithic habitation remains have ever been identified. The Fayoum's Neolithic artifacts inform us about the predominant subsistence activities of the region, but they do not directly provide information about the social structure of these groups. For this we turn to the comparative method and a variety of ethnographic sources. The generalized social structure of other known hunting-gathering groups adds some information on the probable nature of pre-state Fayoum social structure.

In all likelihood, evidence of Egypt's earliest sedentary communities now lie under meters of accumulated sedimentation along the shores of the Nile. The early agricultural record of the Fayoum could have more to do with the falling level of Lake Qarun during this period than it does with the Fayoum as the earliest site of agriculture. The sites of early agriculture along the Nile are now also buried under years of silt and shifting river and cannot be recovered.

> It appears that between 8000 and 5000 B.C. the Egyptian floodplain was lower than it is today and the valley narrower; hence in most places even the cemeteries were located along the margins of the flooded land at that time are now buried under more recent deposits of alluvium. (Trigger 1983:10)

Wenke echoes a similar view,

> The Fayyum Neolithic peoples may have been settlers from the Nile Valley, where agriculture may have been established many centuries before it appeared in the Fayyum. If domesticated wheat, barley, sheep, and goats were introduced to Egypt from SW Asia, as is commonly supposed, presumably they would have been

> established first in the Delta and Nile Valley, which probably had a much higher agricultural potential than the Fayyum. (Wenke et al. 1988:47)

It is also likely that the Nile Valley and Delta regions were not reliant on agriculture because these lush regions had such favorable foraging conditions and thus less pressure was on them to make an agricultural transition.

Caton-Thompson's expedition in the 1920s first identified the presence of two distinct neolithic tool traditions in the Fayoum. These two assemblages are known as Fayoum A and Fayoum B though there was an initial confusion concerning which tradition antedated the other (see Forde-Johnston 1959; Hayes 1964; Caton-Thompson 1926), there is now general agreement that Fayoum B preceded the Fayoum A (Wendorf et al. 1976a; Hassan 1986a).[3]

Fayoum B cultures are at times referred to as "Qarunian" cultures. The general composition of both Fayoum A and B assemblages is that of backed blades and side scrapers. The Fayoum B assemblages are predominantly "chipped celtiform tools, including ovate and hoe shaped forms" and backed bladelets (Beadnell 1903; 1905; Hayes 1964:224), and concave points (Caton-Thompson & Gardner 1934; Wenke et al. 1988; Wendorf & Schild 1976b). There are no pottery forms associated with the Fayoum B cultures. Some Qarunian assemblages have been found <u>in situ</u> of Premoeris lake silts and have been dated to 6000 B. C. (Clark D. 1987:6; Wenke et al. 1983).

Fayoum A assemblages include triangular points, flint adzes, leaf-shaped points, polished axes, pressure flaked blades, and pebble pecked tools (Hassan 1986a & 1986b; Wendorf et al. 1976a; Caton-Thompson & Gardner 1934; Hayes 1964; Wenke et al. 1981, 1982 & 1988; Driesch 1987; Ginter et al. 1980; Kozlowski et al. 1984). There are similarities between Fayoum A lithic types and those found in Libyan assemblages of the same period (O. Bates 1970:145). Pottery has also been found with Fayoum A assemblages, predominantly handmade polished red wares that include: large cooking and storage pots, bowls and "flat bottomed pedestal cups" (Caton-Thompson & Gardner 1934; Hayes 1964:222).

Wendorf concludes that the continuity of lithic assemblages from the terminal paleolithic to the neolithic Fayoum A collections indicates the Fayoum A culture is the progressive extension of local paleolithic culture (Wendorf & Schild 1976b; Hassan 1980a & 1980b).[4] It may be inferred from tool assemblages and osteological materials that Fayoum B populations relied primarily on hunting and collecting activities, while the later Fayoum A groups were more sedentary agriculturalists (Caton Thompson & Gardner 1934). The crops grown were non-indigenous varieties of emmer wheat and barley. The parent stocks of these plants have been identified as originating not from African regions but from the Mesopotamian region (Wenke 1989).

Site excavation by Gertrude Caton-Thompson in the 1920s provide the only evidence of grain production during the Fayoum's Neolithic period. In an area to the North above the lake she excavated 67 grain silos that she assigned to the Fayoum A period. Wenke notes some degree of caution for this date's assignment.

Neolithic communities in the Fayoum relied heavily on fish from Qarun lake. Brewer's analysis of fish skeletal varieties suggests that Qarunic cultures made use of some sort of boat to enable them to catch the deep dwelling fish species (Brewer 1985; 1989; 1991). Fishing was clearly an important component of the Fayoum Neolithic subsistence strategy. Brewer and Friedman concluded that,

> Based on the number of identified specimens per taxon (NISP), fish accounted for 94.4% (4171 NISP) of the entire Qarunian faunal assemblage and 71% (4585 NISP) of the Neolithic assemblage. (Brewer & Friedman 1989:6)

Brewer's analysis of fish skeletal remains of the seasonally occupied sites found that the bulk of the fish caught from Lake Qarun was harvested in the months of Spring, Summer, and Fall <u>throughout</u> both the Fayoum A and B epochs. To him this argued against permanent dwellings during Fayoum A times. He reasoned that permanent settlements would practice year-round fishing at a constant intensity, thus the Fayoum A deposits should have had more winter fish remains.

Conspicuously absent among Neolithic artifacts from the Fayoum are the remains of any permanent dwellings. It would normally be expected to find some sort of dwelling with known sedentary agriculture, especially with the extraordinary preservation conditions of the Fayoum, but to the present time, the only possible dwelling remains that have been found are the remnants of what may have been house posts (Kozlowski 1983; Ginter & Kozlowski 1983:40-42). Wenke concludes that only temporary dwellings (whose remains would not survive thousands of years) were used.

> It seems likely that even if the Fayyum peoples habitually used perishable materials for their houses, permanent occupation for even a few years would have produced sufficient densities of artifacts and deposits in at least some locales to resist deflation, and thus be evident today. (Wenke 1988:46)

Hassan differs on the relative effects of deflation rates in such a climate. He assumed that "archaeological sites occupied during arid episodes are not likely to be preserved as a result of aeolian deposits" (Hassan 1986a:68).[5]

One possible explanation for the lack of habitation site remains is that these neolithic peoples engaged in pastoral activities for a substantial degree of their livelihoods. There is archaeological evidence of possible domesticated sheep and cattle being kept in the Fayoum during the Neolithic period (Caton-Thompson & Gardner 1934; Brewer 1985 & 1989).[6] Farming may not have been the primary mode of subsistence (see Hassan 1986a:69). The world's early states and non-state sedentary agricultural societies were pestered by pastoral raids (Khazanov 1984;

Stahl 1989:28). The Fayoum may have functioned as a base region for such nomadic raids on the growing polities of the near by Nile Valley.

Kenneth Russell has modeled a subsistence strategy for the neolithic settlements in Jordan in which semi-mobile pastoralists raised grains to supplement their herding activities (Russell 1988). Combining evidence of stone corrals, osteology, grain caches and lithic tools, Russell pieces together evidence of communities that subsisted from seasonal pastoral and sedentary activities.[7] Hassan does not conclude that the Fayoum's neolithic cultures had a pastoral economy, but he is convinced it was some variety of a mixed economy. He does estimate that Egypt's Western Desert's rainfall levels were sufficient to sustain a pastoral existence during the Neolithic (Hassan 1986a:69).

Though there is archaeological evidence indicating agriculture in the Fayoum during the Neolithic period, there is nothing which directly suggests the presence or absence of irrigation. Still, from what is known about the requirements of the varieties of cultigens found, and the prevailing climatological conditions, it may be inferred that some form of simple irrigation agriculture was practiced during this period.

The type of irrigation technology used need not have been complex, or even required the construction of delivery canals. As with other Neolithic farmers around the world, the fertile shore along the lake's edge could have been planted with grains. The technology of water delivery could have been as rudimentary as water transport jars or a device similar to a portable shadouf along the shore of Lake Moeris. There is no reason to suppose that the simple levels of irrigation in this period would necessarily have a major impact on the social organization of the groups living along the lake shore, but the increased sedentary lifestyle that accompanies an increased reliance on agricultural production certainly altered social structures.

It is possible that the Fayoum Oasis was abandoned for some centuries following the Qarunic period (as Wenke 1988 argues), but it is also likely that this gap in data results from the progressively receding lake levels. Most of the known Fayoum A artifacts are located above the 33 feet elevations, while the Fayoum B collections are "scattered between the 33 foot and 13 foot beaches and reached as low as the 7 foot beach" (Hoffman 1979:187). The trailing off of Fayoum B artifacts could demarcate a hunting-gathering group following the edge of the most limiting factor of their ecological niche: the water-line of Lake Qarun.

Fekri Hassan has calculated that, in as short a time as 42 years, Lake Qarun could dry up completely through evaporation if cut off completely from the source waters of the Nile (Hassan 1986b:494; cf. Ball 1939:213-215). It is possible that Fayoum populations continued to follow the receding shoreline of Lake Qarun during the 100 or so years it took for the water to evaporate.

Brewer's own data on the habits of the Lake's shallow water catfish (Brewer 1989:109-118) make it hard to imagine bands of hunter-fishers doing anything but following this increasingly easy to capture food source until the last of the water disappeared.[8] Brewer's research indicates that catfish can sustain large numbers in shallow water environments, so it would not make sense for a group to abandon the pursuit of such a high protein source just as it was becoming more available.

Once Lake Qarun completely evaporated, the previous lake bed would not have been a barren desert plane as has sometimes been supposed. Various pockets of lush green must have appeared across the littoral surface where the Fayoum's springs bubbled to the surface. Perhaps future excavations at the sites of modern springs will provide more information on the period of intermittent lake levels. The neolithic Fayoum is a topic needing further research.

Summary and Conclusions

The geological formation of the Fayoum created ecological conditions unlike those found anywhere else in Egypt. The Fayoum Depression's proximity to the Nile and the longstanding hydraulic commerce with its waters has created an ecological setting distinct from the other depressions of the Western Desert. The declivity of the

Fayoum's land allows for the possibility of gravity-fed irrigation from these nearby Nile waters. In later times this declivity would allow canal networks to distribute irrigation water, but during the Neolithic period it created the great lake which fed the populations living along its shore.

The Neolithic populations of the Fayoum lived in small groups and were the last of it's human inhabitants to live without a bureaucratic state governing their lives. Whether big-men, chiefdoms, or "organized anarchy" characterized the political structure of this period, there is no ethnographic precedent of such political forms ever organizing systems of irrigation agriculture of the scale and nature of those from post-Neolithic periods. The Neolithic period demonstrates the maximal cultural evolutionary development of the region without state intervention or centrally controlled irrigation agriculture.

Any agricultural improvements undertaken at a strictly local level would have produced minimal returns. At a minimum, a Fayoum-wide coordination of hydraulic activity would have been required to significantly increase productions, though the effects of such a regional effort would have been minimal without an up-stream reworking of the Fayoum's water source.

Such regional and supra-regional efforts and coordinations were not to occur until the Dynastic period, when Upper and Lower Egypt were managerially united under the office of Pharaoh. As we will see, the coordination of the Fayoum's landscape and hydrology produced magnificent agricultural returns, but likewise required a massive work force governed by a centralized administration.

Notes

1. The Western Desert lacked permanent water courses during all the Quaternary Period, thus most of its erosion has occurred through wind action (abu al-izz 1971:184).

2. I had opportunities to travel by foot, camel and Land Rover into the desert surrounding the Fayoum on a number of occasions. Within a dozen kilometers of Lake Qarun there are occasional ravines with scrub plants. The areas next to these ravines have subtle proof of the desert's ability to sustain life and nurture a complex ecosystem. The tracks and dung in the sand indicate the presence of a diversity of mammal, reptile and bird life.

3. For further background readings see: Bates et al. 1915; Castillos 1973; Caton-Thompson 1925, 1927, 1928a & 1928b; Caton-Thompson & Gardner 1926a, 1926b & 1929; Neilson 1903; Phillips 1971; Phillipson 1985; Ralph et al. 1973; Seton-Karr 1898, 1904a, 1904b, 1905 & 1907; Vermeersch et al. 1982; Ginter & Kozlowski 1987.

4. Fayoum A is thought to have preceded Badarian culture found in Upper Egypt (earliest date 4800 B.C) and the Merimda culture of the Delta (4400 B.C.) (Hassan 1986b:91). There is a general similarity of artifact assemblages except for the lack of metal in Fayoum A collections. (See Trigger 1983:6).

5. I surveyed several caves located in the yet unsurveyed region in the southern and southeastern area of the Fayoum that have Fayoum A tools weathering out of them. One particularly promising cave is located a few kilometers to the north west of the Malak Gabreel coptic monastery. This cave is located at an elevation approximately 30 meters above sea level, and could have provided shelter above the prosperous lake during the neolithic. The hills 15 kilometers to the north below the Sileh pyramid also contain a number of unexplored and unexcavated caves that could prove to be the location of several neolithic habitation cites. The presence of a number of anti-aircraft guns and other hidden military facilities in this region leaves the possibility of present surveys doubtful.

6. The question of whether or not these sheep were domesticated is not clear (Higgs 1967:166).

7. This model fits well with what is known of contemporary pastoralists' direct and indirect involvement with agriculture. Khazanov has shown a historical relationship between pastoral peoples and sedentary agriculturalists (Khazanov 1984), and a wealth of ethnographic data demonstrates that classic pastoral societies keep seasonal gardens (Evans-Pritchard 1940; Dyson-Hudson 1984; Khazanov 1984).

8. Ali Shafei Bey, a Fayoumi Irrigation Inspector in the 1930s noted that in Lake Qarun's historic past "more fish were caught in the low stage of the lake than when its level was high" (Shafei 1940b:308).

CHAPTER 5
IRRIGATION AND THE FAYOUM: THE DYNASTIC PERIOD

> In a landscape characterized by full aridity permanent agriculture becomes possible only if and when coordinated human action transfers a plentiful and accessible water supply from its original location to a potentially fertile soil. When this is done, government-led hydraulic enterprise is identical with the creation of agricultural life. This first and crucial moment may therefore be designated as the administrative creation point.
>
> ---Karl Wittfogel

The Dynastic Development of the Fayoum

In the Early Dynastic and Proto-Dynastic periods the Fayoum depression was mostly a large lake--known then as Lake Moeris--much of the land mass was a marshy and swampy ecosystem.[1] The elevation of Lake Moeris in the Third millennium B.C. (Proto-Dynastic Period) was +30 meters above sea level. As shown in figure 5-1, most of the present Fayoum was submerged beneath the lake's waters at the beginning of the Dynastic period (Hassan 1986). The marshy frontier environment of Dynastic Fayoum hosted several debilitating diseases and other health risks especially malaria and schistosomiasis. There are no good figures on what percentage of Dynastic populations were infected by schistosomiasis but its presence is documented in dynastic Egyptian mummies.[2]

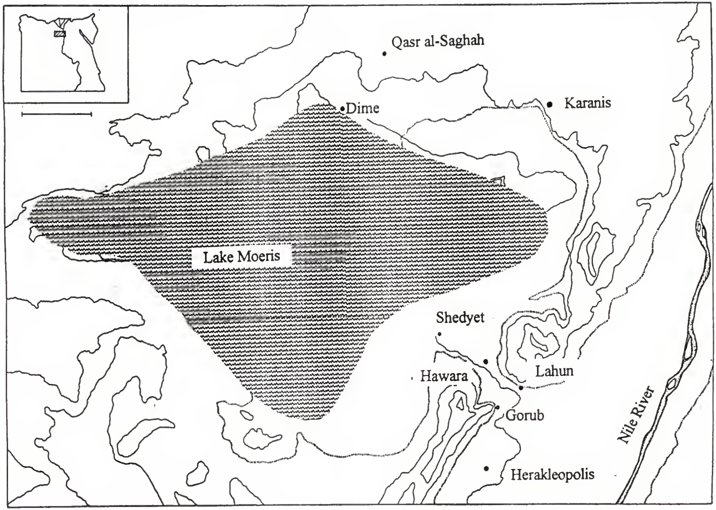

Figure 5-1. Map of Lake Qarun (Moeris) Levels in Dynastic Times.

Butzer (1976) and Hassan's (1986b) geoarchaeological research into past water levels indicates that lake levels fell during the Pre- and Early Dynastic periods. Lake levels again rose to 18-22 meters (above sea level) during the Old Kingdom, and then fell back to low levels during the low Niles of the first Intermediate period (Hassan 1986b:491). Hassan's fieldwork indicates a Middle Kingdom Lake level of at least 20 meters.[3]

The Fayoum was a favorite hunting ground for Royal expeditions throughout the Dynastic period. The Lake's large water mass and surrounding swamps attracted a variety of water fowl year round, and, during the winter months attracted many species of European and Asian migratory birds.[4]

The major Fayoum towns from the Dynastic period were either located directly along the lake, or the main canals of the period. Today many of these towns are in the barren desert surrounding the depression.[5]

The picture of land ownership and tenure for the Fayoum and the whole of Dynastic Egypt is anything but clear. The bulk of land was owned and managed by the centralized state, but some evidence indicates that "private individuals could own farmland at all periods of ancient Egyptian history" (Baer cited in Ward 1984:63). Though most scholars (e.g. Kemp 1983) believe private land ownership was limited (almost nonexistent), Ward believes that virtually anyone could own agricultural land. Despite the evidence for some degree of private land ownership in the Dynastic period, the state predominantly owned and controlled Egypt's agricultural lands.

<u>The Old Kingdom</u>

There is little known about the extent of the Old Kingdom's presence and influence in the Fayoum. Artifacts more than architecture testify to this limited presence. Caton-Thompson wrote of this period that:

> Since. . .the people of [the Old Kingdom], judging by the abundance of their relics, appear to have been more concerned with the Fayum than the Middle Kingdom folk to whom the great irrigation works are generally assigned, it is not, we believe, at all improbable that some sort of Nile connection was, at this early period, artificially maintained. (Caton-Thompson & Gardner 1934:97)

Caton-Thompson's excavation of Kom M (located in the desert to the north of Lake Qarun) revealed an assortment of Old Kingdom blade tools and pottery (Caton-Thompson & Gardner 1934:95-96). Her fieldwork also discovered evidence of Dynastic quarries located in the desert to the north of the Fayoum Depression.[6]

Old Kingdom communities living along the desert edge north of Lake Moeris relied on intricately designed rain catchment technology for some of their drinking water. Underground water-storage holes and basins were fed by water collected on the surface and delivered by induction gutters (Caton-Thompson & Gardner 1934:117) in a system of catchment similar to that used in Israel's Negev Valley or by Mayans in the New World (Negev Research Project 1977; Doolittle 1990).

Traditional analysis of the evolution of the Egyptian state recognize the successive low Nile floods as causing the breakdown of centralized control of the state and eventually the political collapse of the Old Kingdom. During the First Intermediate period that followed, individuals from various nomes competed for supra-regional dominance. The clan that emerged to dominate the whole of Egypt (known as the "House of Khety") came from Herakleopolis (a.k.a. Nenni-nesu, Kees 1961:214), a city located adjacent to the point where the Fayoum Depression meets the Nile Valley. Very little is known about these early rulers of the Dynasties of the First Intermediate Period. In fact Kemp wrote that, "whether they took over the Memphite court or continued to rule from Herakleopolis is, like practically everything about them, unknown" (Kemp 1983:113).

There may have been some connection between Herakleopolis' rise to power and the Fayoum. Perhaps irrigation and the natural richness of the Fayoum allowed the House of Khety to rise to a position of power over Egypt. Little is known about the exact levels of irrigation and agriculture in the Fayoum during the Intermediate Period, but the remains of wooden hoes and plows as well as a bronze plowshare excavated at Kahun (Kahun aka Lahun) demonstrate an agricultural base for the region.

The Middle Kingdom

The Middle Kingdom provides us with the first good evidence of the Fayoum's extensive state run hydrological development. Amenemhat I organized an intensive dredging project along the Hawara Channel which joined Bahr Yusef freely with the Nile. Sestosterus II (possibly) implemented the construction of some sort of barrage-embankment at the mouth of Bahr Yusef's entrance to the Fayoum at al-lahun.

The layout of Kahun suggested to Egyptologist Barry Kemp a "classic example of the application of bureaucracy to community creation on the scale of a complete town of no mean size by ancient standards" (Kemp 1989:157). To Kemp this was a revelation of the Fayoum's functional role during this period. These Middle Kingdom architectural remains in the Fayoum testify to the extent and importance of governmental forces in the organization of the Fayoum's productivity. Rosalie David concluded that the Middle Kingdom city of Kahun could have housed the work force that built the hydraulic works of the Fayoum:

> The kings of the 12th Dynasty developed various irrigation projects in this area, and Kahun would also have played a significant role in these concerns. It undoubtedly became a prosperous and important centre, and it would be wrong to regard it simply as a pyramid workmen's town. (David 1986:3)

Little is known about the organization of construction and maintenance of the Fayoum's irrigation canals during the Pharaonic period, but for the whole of Egypt it is well established that corvee and state coordinated labor pools were used for such tasks (Butzer 1976; Trigger et al. 1980; Hays 1971).

Hydrology: Reservoir vs. Reclamation

The large-scale agricultural exploitation of the Fayoum began in the Middle Kingdom. The two most significant hydro-agricultural projects for the Fayoum during the Middle Kingdom were the dredging of the Hawara Channel, and the construction of some sort of massive dike at al-lahun (though the exact form of this dike is anything but clear). The Hawara project was carried out to increase the amount of water that could enter the Fayoum during flood periods. The most promising theory is that the bottom of the Hawara Channel was dredged below Nile flood levels so that run-off water from potentially devastating high flood years could be diverted into the Fayoum. Thus the Fayoum would be inundated, but the Nile Valley would not be devastated down-river. Another reason for dredging the Hawara Channel could have been so more water could be delivered during seasons of low water. A dredging project of this size indicates a massively centralized coordination effort. The canal could have been dredged for both of these reasons, or for only one of them--one's interpretation of this largely depends on what is to be done with the questions concerning the Dynastic al-lahun embankment (Shafei 1960).

The modern embankment at al-lahun is impressive. Gisr Bahlawan and Gisr Gadalla are the modern names given to the large embankment stretching for over 8 km from the al-Lahun pyramid (at the immediate north) to the ancient city of Gorub (at the immediate south) (see Figure 5-2)(Griffith 1897a; 1897b; 1898).[7] Gisr Bahlawan refers to the portion of the wall to the south of the town of al-lahun, while Gisr Gadalla refers to the northern portion of the wall. The wall's initial construction has been attributed to the Middle Kingdom administration of Sestostorus II largely on the authority of nearby Middle Kingdom architectural remains (David 1986).

The remains of the Gisr Bahlawan/Gadalla wall are still standing. The eastern side of the wall (Nile side) has been reinforced with (modern) fired bricks, and a town (al-Lahun) and a roadway have been built atop the wall.[8] At the northern most end of the wall is the Middle Kingdom (XII Dynasty) al-Lahun pyramid of Sesostris II. Eight kilometers away at the southern end of the wall are the remains of the Dynastic city of Gurob.[9]

The extent of the al-lahun embankment in Dynastic times is problematic. Sufficient investigations of the embankment have yet to be undertaken to determine the dates of the wall at various times. The purpose of the Dynastic al-lahun embankment (dam) also remains problematic. There are two predominant theories relating to the construction of the al-lahun dike: there are the "reservoirists" who believe the dam was built to increase the size of Lake Moeris, and there are the reclaimationists who hypothesize that land reclamation campaigns were enacted to reduce the area of the great lake.

The Reservoir Theory

Ball, Kees, Mehringer and others believe that the Hawara canal was dredged and perhaps a portion of the al-lahun embankment was built so the Fayoum could be an overflow reservoir for unusually high Nile waters. During early Dynastic times, Lake Moeris' water levels was just a few meters below that of the Mediterranean Sea. This level remained about the same until the twelfth dynasty (Ball 1939; Mehringer et al. 1979), when the lake rose to a height of approximately 18 meters above sea level (Ball 1939:199). Mehringer, Petersen and Hassan base their comments on the belief that the embankment was not built until Ptolemaic times.

> During the reign of Amenemhat I (1980-1970 B.C.), the Hawara Channel and Bahr Yusef, a canal connecting the Fayum depression with the Nile, were joined as one of the great Nile control projects of the ancient Egyptians. As a result, the lake could have been maintained near 18 m above sea level, in free hydraulic communication with the Nile, and thereby have served as both a flood-escape and reservoir. Significant fluctuations undoubtedly followed but, this level was close to that seen by Herodotus.

> The lahun Embankment was modified during the reigns of Ptolemy I and II (323-246 B.C.). (Mehringer et al. 1979 emphasis added)

A lake level of 18+ meters would have put Lake Qarun at equilibrium with the flow of high Nile levels. Thus, during summer floods, water would flow in and not out of the Fayoum basin. It is at this time that those favoring the Reservoir Theory believe (most likely) Amernmhat I's engineers rechanneled the flow of Bahr Yusef through a man-made deeper passage into the Fayoum.

The reservoir theorists see Amenemhat I's restructuring of the channel at al-Lahun as an effort to transform the Fayoum basin into a gigantic emergency overflow reservoir for the Nile during years of unusually high floods. Such floods caused widespread destruction throughout Egypt by washing out topsoils, devastating dikes and canals, over-silting, and causing salinization through leaving unwanted excess minerals behind during prolonged periods of water standing on fields. Ball noted that:

> The lake thus functioned as a combined Nile flood-escape and reservoir, not only protecting the lands of Lower Egypt from the destructive effects of excessively high floods, but also increasing the supplies of water in the river after the flood season had passed. (Ball 1939:199)

Another hydraulic project possibly undertaken by Amenemhat I's engineers presents more interpretive problems to these scholars. This is the construction of what is known in modern times as "Gisr Bahlawan".

George Rawlinson (1886:169) decided--and others have carried on a tradition--(i.e. Hewiston 1986, Boak 1926:358) that the al-lahun embankment was built by Sesostris II to raise the level of Lake Moeris. Rawlinson mistakenly decided that Lake Moeris had existed not as a predecessor to Lake Qarun, but as a separate artificial lake stretching from al-Lahun to Medinet Fayoum (1886:169). Many authors propagated this misconception of two lakes (e.g. see Redman 1978:282, figure 9-1). Rawlinson must have interpreted the remains of the Shedhat wall as being left from this supposed engineering campaign, for the map he supplies shows the length of the retaining wall following this path.

Garbrecht accepts the Dynastic date of the wall's construction and maintains it was built to retain runoff waters inside the Fayoum. Garbrecht believes this was done to accomplish the following:

> (1) cleaning and reactivating an old river branch which once led from the Nile River into the Fayoum.
>
> (2) closing the connection between the Nile valley and the depression by means of dams in order to prevent uncontrolled flooding and to regulate the inflow.
>
> (3) clearing and draining the marshy and reedy plateau between the eastern mountains and the low-lying evaporation lake in the west.
>
> (4) providing an artificial lake. . .to store part of the flood waters of the Nile River. (Garbrecht 1987).

Garbrecht's view is different from most "reservoir" hypothesis who place the al-lahun's construction at a later period.

> It is, I think, probable that a large part at least of the ancient embarkment which still surrounds the entrance to the Hawara channel near Lahun, and which has hitherto been generally thought to have been constructed by Amenemhat, may in reality represent one of the barrages erected by Ptolemy I; for so far as I have been able to ascertain, there is no actual evidence that would date the bank prior to the Ptolemaic, and as has been shown above, a barrage at the entrance to the canal would hardly have been necessary for Amenemhat's purpose, though it was absolutely essential for Ptolemy's. (Ball 1939:212)

Ball goes on to suggest (following Sir Hanbury Brown) that the northern part of the embankment could have been a Dynastic project, while the southern portion of the wall could have been a Ptolemaic addition (Ball 1939:213) (see Figure 5-2). This northern portion of the wall would have been a massive flood-capturing-flume that could divert high waters into the Fayoum basin. In Ball's view the Ptolemaic reclamation goals for the Fayoum were easily furthered by adapting and extending this wall to the south.

Paleo-environmental evidence presented by Mehringer et al. offers good proof that the level of Lake Moeris during the Middle Kingdoms were as high as 20 + meters, thus supporting the reservoir hypothesis (Mehringer et al. 1979).

The Reclamation Theory

The Reclamation Theory differs from the Reservoir Theory by positing that the al-lahun embankment was built to keep water <u>out</u> of the Fayoum, not keeping it in. Rosalie

David maintains Sesostris II of the 12th Dynasty built the large dike to reclaim submerged land of the Fayoum:

> By artificially reducing and regulating the inflow of water to the Fayoum basin, a natural rapid evaporation of the lake surface would have been achieved so that additional land was made available. This land was then protected from reflooding by a system of dikes and drainage canals. (David 1986:41)

David attributes the wall to Amenemmes III (Sesostris II's successor) who built subsequent levees in the area of Crocodilopolis, which reclaimed an additional 17,000 acres (David 1986:41). Unfortunately, insufficient archaeological work on the al-lahun embankment has been completed to date, and it is presently unknown how large or what shape the embankment was during Dynastic times. If the current embankment is an extension of the Dynastic embankment then it's function is apparent from the form of the wall.[10] There is however no good evidence that the entire current embankment resembles the Dynastic structure.

What we know about the Dynastic dredging of the Hawara canal and the levels of Lake Moeris suggests that it was unlikely any Middle Kingdom administrator extended an embankment across the entrance to the Fayoum. Ball's suggestion that the northern section of the embankment (Gisr Gadalla) was a Dynastic construction to help divert high Nile waters seems quite plausible.

The New Kingdom to End of Late Period

There is little monumental archaeological evidence of the New Kingdom in the Fayoum except for the ruins at Gurob--founded during the 18th dynasty. There is ample evidence however that the sites inhabited during the Middle Kingdom for the most part continued to be used during the New Kingdom. The designation of two separate administrative titles during the New Kingdom may indicate a period of population growth in the region.

The Fayoum region "lapsed into great quiet with the decline of the Ramesside Period" (Kees 1961:227). Tax lists indicate that Ramesses V owned private land in the Fayoum and surrounding areas (Kees 1961:227). In the twenty second Dynasty, Osorkon I built a large defensive fortress to the southeast of the al-Lahun entrance to the Fayoum near Gurob (Thomas 1981). This too has been demolished and little is known of its form or function. The region was subject to increasing raids from Libyan nomads from the time of Merenptah (the 19th Dynasty ruler who immediately followed Ramesses II) until the end of the Dynastic era.

Herodotus

Herodotus was a Greek political exile who journeyed beyond the eastern edges of the 5th century (B.C.) Greek empire and amassed tales and adventures that would later be the source for his Histories. Herodotus claimed to have visited the monuments of the Fayoum. Issues of accuracy and

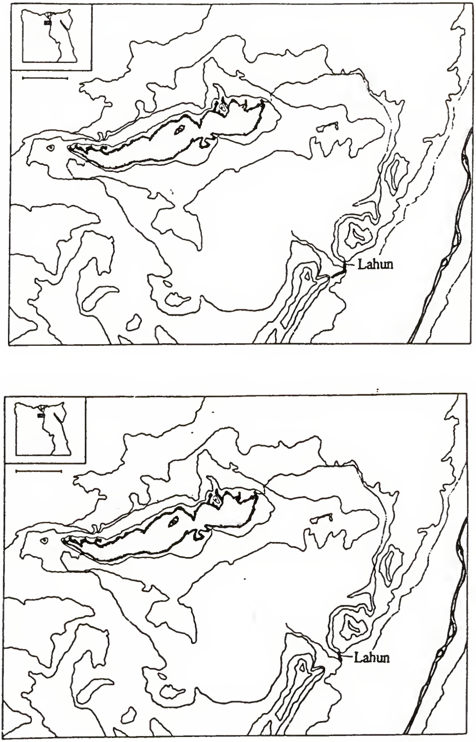

Figure 5-2. The al-lahun Embankment.

reliability are raised by independently verified and contradicted aspects of his report. Egyptologists and Greek scholars generally either reject him outright or salvage aspects of his report that fit with independent material evidence (cf. Armayor 1985; Heath 1886). Though historians from Strabo to the present have recognized a high degree of plagiarism and absurdity in his work, much of his writing still serves as our only basis of knowledge for some aspects of the ancient world.[11]

Herodotus supposedly traveled through the Delta to Heliopolis and Memphis, then up the Nile as far as Nubian Elephantine. During his trip up-river he reports having traveled through the Fayoum where he found several spectacular monuments; A gigantic labyrinth, a large fresh water man-made lake by the name of Lake Moeris, a colossus statue, temples dedicated to crocodile gods, and two large pyramids resting in the waters of Lake Moeris.

There are several reasons for questioning the validity of Herodotus's report on the Fayoum. As Armayor put it, the problem with almost every contemporary analysis of Herodotus' description of the labyrinth is that they "un-critically assume the autopsy. . .at the outset" (Armayor 1985:2). There is enough evidence on the mistakes contained in Herodotus that we can safely assume he did not personally visit the Fayoum, but instead recorded the reports of the area (as well as confusing reports of other areas) in a first person voice to add spice his narrative.[12]

Though Herodotus' actual travel to the Fayoum is doubtful, his accounting of the region's hydrology demonstrates it's importance at the time. Herodotus records the presence of a large canal bringing water directly to the Fayoum from the Nile. There is some confusion about the flowing of water both in and out of the Fayoum (a confusion continued by later scholars). Herodotus makes clear that the Fayoum-Nile connection was well known in the 5th century.

> The water in the lake does not come from the place where it is, for the country there is very deficient in water, but it has been brought thither from the Nile by a canal; and for six months the water flows into the lake, and for six months out into the Nile again; and whenever it flows out, then for the six months it brings into the royal treasury a talent of silver a day from the fish which are caught, and twenty pounds when the water comes in. (Herodotus 1910:77)

The End of the Dynastic Period

Factors internal and external to Egypt were instrumental in leading to the end of the Dynastic period. From the XIX Dynasty to the beginning of the Third Intermediate Period, there are textual references to an increased presence of nomads from the Western Desert. They were first known simply as "desert dwellers", then referred to as two separate groups, the Meshwesh and Libu (O'Connor 1983:277). These Libyan raiders were a significant presence, and they were listed in work records of tomb builders in the Valley of the Kings as being responsible for causing walkouts due to fear of raids. (Cerny 1975:616-619).

Large numbers of these nomads settled at the eastern entrance of the Fayoum near the fortress city of Heracleopolis (O'Connor 1983). When the New Kingdom finally collapsed it was even a member of this originally Libyan band that assumed the title of Pharaoh Sheshonq I, the primary ruler of the XXII Dynasty (Kees 1961:227; O'Connor 1983).

These Libyan forces were an important factor in the demise of the Pharaonic state. Though little is known of either the Libu or the Mshwash, they are described as wearing non-Egyptian dress, mention is made of Libyan towns, though a pastoral mode of production is suggested by the reports of livestock captured by Ramesses III (O'Connor 1983:272-273; Cerny 1975:617; Leeahy 1988).

O'Conner finds a contradiction between the mention of the towns of the Libyan Chief Meryey and a suggested Pastoral mode of production. But from what is now known about the evolutionary relationships between pastoral and sedentary groups, a nomadic group's knowledge of cities would be ethnographically expected (Khazanov 1984). Too little is known of the Libyan region to postulate the reasons for these systematic raids, but at the end of the New Kingdom, much of the Western Delta lands were settled by migrants (or "invaders") of Libyan descent.

Douglas Johnson, a historian of pastoral societies in East Africa, noted that the Libyans settling along the eastern edge of the Nile during the Dynastic period were a force to be kept at bay by the ruling powers.

> Whenever the power and authority of the central regime declined, they and their kin beyond the frontier posed a serious threat to the stability of the settled community. (Johnson 1973:98)

This relationship between Egyptian states and nomadic populations continued on long past the Dynastic period (Mitwalli 1952).

In the 386 years from the end of the Dynastic period to the coming of Alexander the Great, Egypt was ruled briefly by Ethiopians, Assyrians and Persians, and administrative centers were located at cities in both Upper and Lower Egypt. These were times of decentralized control and from what is known of the depleted irrigation works the Ptolemies inherited, it can be said that the weakened government was not capable of maintaining irrigation levels anywhere near those of the Dynastic period (Lloyd 1983).

Summary and Conclusions

Butzer's theory of the de-centralized Dynastic Egyptian state (as discussed in Chapter 2) is further weakened by the evidence of the Fayoum's Middle Kingdom hydrology. Massive labor forces under Dynastic rule dredged and channeled the waterway at Hawara and later transformed hundreds of square kilometers of the Fayoum from lake and swamp-lands to arable farm lands.

Whatever the exact nature and extent of the Dynastic developments at al-lahun and Hawara, various administrators directed massive labor forces in the construction of these works. Contrasted with the previous neolithic communities, the Dynastic inhabitants of the Fayoum took measures to control water: the very limiting feature of agricultural life. Unlike previous periods, Dynastic rulers had access to the surplus labor of Egyptian society and this surplus could now be directed towards monolithic projects such as those relating to Fayoum hydrology. The fact that such sizable labor pools could be brought in from various regions and directed to such unified work presents a very different view of the Egyptian state than that put forth by Butzer.

The Dynastic hydraulic organization of the Fayoum was different from any organization effort that was to follow. The Dynastic efforts were primarily concerned with hydraulic control while later periods were further concerned with establishing settlements filled with grain producing farmers. We will see that as the state began to increase its Fayoumi agricultural profits, its investment in the region's hydraulic infrastructure intensified even more. The Fayoum's post-Dynastic history is a succession of efforts (relative successes and failures) to achieve a balance between the benefits of centrally managed irrigation and the costs of supporting such the requisite heavy bureaucratic force.

Notes

1. Ancient Egyptians believed that the world began as a planet engulfed in water. Life emerged from the water of the primordial sea of Nun, which in one version of a Dynastic creation myth is identified as Lake Moeris (modern Lake Qarun) (Kees 1961:224).

2. The earliest evidence comes from a 3200 year old mummy (see McNeill 1976:44 note 9), and the hieroglyphic representation of schistosomiasis by the symbol of a red penis. The debilitating effects of Bilharzia and other water born diseases also could have diminished the farmers' ability to resist the imposition and demands of the early State. As William McNeil suggests,

> Despotic governments characteristic of societies dependent on irrigation agriculture may have owed something to the debilitating diseases that afflicted field workers who kept their feet wet much of the time, as well as to the technical requirements of water management and control. . . .(1976:45)

While this may be putting it a little strongly, the general ill-health and constant state of malnourishment of the Egyptian population facilitated the lack of meaningful resistance to the interloping State.

3. Hassan's lake level calculations discount Caton-Thompson and Gardner's earlier theory of constant lake level reductions (cf. Hassan 1986:491; Caton-Thompson & Gardner 1934). In the Middle Kingdom Lake Moeris rose again to levels between 15-18 meters. Hassan's investigation of the Middle Kingdom colossi pedestals at Biyahmu (in what is now located in the center of the Fayoum Depression) revealed

> a stratified section of lake shoreface deposits above the ground-level of one of the pedestals, underlaying a fallen block of stone from the pedestal. The deposits are indicative of a rise of the lake following construction of the colossi and shortly before their partial collapse. (Hassan 1986:491)

4. Marsh birds were hunted with nets and throw-sticks (Kees 1961:226). The known hunted wild game species of the period include: gazelle; ibex; onyx; ox; sheep; fox; hyena; jackal; wolf; desert hare; leopard; ostriches; desert fox;

hippopotamus; crocodile; partridge; buzzard; quail; geese; pigeon; curlew and other waterfowl (David 1986:143-145).

5. The known towns along the canal include Hawara (a.k.a. Hwt Wrt), Crocodilopolis (a.k.a. Arsinoe, a.k.a. Keman Feris), al-Lahun (a.k.a. Kahun or Htp-Snwsrt). The temple at Qasr al-sagha and the towns of: Bacchias (a.k.a. Kom al-atl). Remains along the southern edge include the New Kingdom temple at Tebtunis (Umm al-Brigat), Kom Ruqqaia and Kom al-Khilwa, Madinet Madi.

6. Caton-Thompson first identified an ancient track cutting across the desert north of the Fayoum to Dashur (site of the "bent" pyramids). The southern end of the road could not be found but its proximity to the known dolerite and gypsum quarries of the Old Kingdom period led Caton-Thompson to conclude the road had originated during this period (Caton-Thompson 1934:109-110). They concluded this was a source quarry for the Old Kingdom tombs of Dashour (Caton-Thompson & Gardner 1934:109).

7. Various authors refer to the al-lahun embankment as a "dike", "dam", "embankment" or "wall".

8. Apparently these bricks were added as recently as 1835 (Ball 1939:227, see fig. 29).

9. The construction of such monuments implies either a large work force over ten to twenty years or, a small work force over a span of centuries. It seems impossible to account for the construction of such a dam without a centrally organized and maintained work force. The absence of any such supporting documents may simply be a problem of the randomness of artifact preservation.

There are historical instances of large scale irrigation works being constructed without the direct control of centralized authorities. As mentioned above, Edmund Leach maintains that the Sri Lankan community of Pul Eliya, built huge irrigation and drinking water storage tanks with the piece-meal labor of small village work-forces over the course of centuries (Leach 1959:8-9; 1961). But the Pul Eliyan case, and others of its type are not applicable to the Middle Kingdom's construction of the dam at the Fayoum's entrance.

Whereas erecting large water holding tanks in Leach's Sri Lankan situation would bring some benefits--catching some amount of rainfall--at each stage of the work's effort, the al-Lahun dam even after completion would bring little benefit to the workers from the immediate area, and the costs incurred by donating a significant amount of labor to such a project would be onerous.

10. As seen in figure 3.2, the wall stretches across the al-Lahun gap as an arc protruding out toward the east (the direction of the Nile), external to the Fayoum. The use of an arced design for dams and retaining walls is as familiar to us in modern times as it was to ancient engineers. The basic principle of this design's strength is the same as that applied in the use of an archway in building bridges or doorways: stress is conveyed away from a central point, and uses the entire structure to absorb the stress. The form of the wall could only have been designed to keep unwanted waters out of the Fayoum (picture modern dams such as the Grande Coulee or Hoover Dam with the direction of water flow reversed). The stability of these structures would be akin to that of a non-reinforced inverted archway. If the date of the form of the al-lahun embankment could be known, it's purpose could be more easily surmised.

11. Among his more glamorous errors are his belief that Ethiopian semen is black, Nebuchadrezzer was a woman, Ramesses II preceded Cheops, the European Alps were a river and that the pyramid of Cheops was built with the profits turned by Cheops daughter from a bout of prostitution. The French Egyptologist Auguste Mariette went so far as to write that "...considering the great number of mistakes in Herodotus...would it not have been better for Egyptology had he never existed?" (quoted in Fagan 1975:20). Black Athena is a contemporary example of the type of flawed scholarship resulting from the uncritical adaptation of Herodotus (Bernal 1987).

12. Using Herodotus' writings--much as Shcleiman had used Homer in his search for Troy--Sir Flinders Petrie excavated the remains surrounding Hawara in 1889 and concluded that the scanty archaeological remains could not settle such questions. There has been no archaeological study since which sheds any more light on the problem, however there is a general consensus that the remains are of a multi-chambered complex, not of a labyrinth. Recently there have been suggestions that the labyrinth described in Herodotus may not have even been in the Fayoum, but instead near Saqqara (Lasken 1991).

Herodotus' record of the Fayoum "labyrinth" sounds remarkably like the Creten one in Theseus' encounter with the Minotaur. Traditional interpretations of this are split along lines of arguing for a basic confusion between stories of a labyrinth in Fayoum and the more famed stories from Crete (Armayor), and arguments defending his claim as factual (Petrie). Armayor argues that Herodotus' version of the Fayoumi Labyrinth leans heavily on Hecataeus' earlier writings. Herodotus' representation of the lake-side labyrinth with its repetitious arrangements of "twelve" chambers, the 3,000 chambers, and the symmetrical adjoining pyramids suggests to Armayor a retelling of Hecataeus' account of the Pythagoreans purgatory (1985:81). Armayor's research indicates a number of structural and factual parallels between Herodotus labyrinth and Ionian mystical beliefs.

> . . . There is much to suggest that [the labyrinth and Lake Moeris] belonged primarily and in the first instance to sixth-century Ionia, and then to a gifted Dorian of Ionian predecessors whom he envied, resented, and emulated all at once, and whom he did not really understand. We should look for the Labyrinth not in Egypt but rather in what the Ionians made of Egypt. (Armayor 1985:6)

Petrie's excavations of the site produced architectural remains of some sort of a palace, but nothing that anyone would consider to be a labyrinth--unless they had already read Herodotus and were out <u>looking</u> for a labyrinth. All of the speculation of the labyrinth's existence aside, the importance of the Hawara pyramid and "labyrinth" complex lies in it documenting some form of State presence along Lake Moeris' lakefront during the Middle Kingdom. Massive palaces and administrative architecture testify to the size and strength of the State in the New Kingdom period.

Herodotus' Lake Moeris is also problematical. He described the lake as 3600 furlongs in circumference and 50 fathoms in depth (Ball 1939:179). This is an incredible distance (over 300 miles, or greater than the linear distance from the Fayoum south to Thebes), and though individuals' judgments of distance are often imprecise, this is too sizable an error to accept as simply a miscalculation.

> I think too that those Egyptians who dwell below the lake of Moiris and especially in that region which is called the Delta, if that land continues to grow in height according to this proportion and to increase similarly in extent, will suffer for all remaining time, from the Nile not overflowing their land, that same thing which they suffer themselves said that the Hellens would at sometime suffer. (Herodotus 1910:11)

Herodotus' confused claims of two pyramids surrounded by the waters of Lake Moeris raise further doubts of his claims to have been a visitor to the Fayoum.

> ...about in the middle of the lake stand two pyramids, each rising above the water to a height of fifty fathoms, the part which is built below the water being of just the same height; and upon each is placed a

> colossal statue of stone sitting up on chair. (Herodotus 1910:77)

Petrie identified the standing pedestals near the village of Biahmu as having once been the base supports of such a pair of colossi. The work of Fekri Hassan suggests that these columns were emersed in the lake during the period of Herodotus visit. Still there is no possibility that the current two standing pyramids of the Fayoum (Hawara and al-Lahun) were surrounded by water during this time. The likelihood of their immersion is also doubtful given that they are constructed not of solid stone, but of sun dried mud bricks that would simply disintegrate from any prolonged contact with water. Some historians such as Ball insist that Herodotus saw the standing columns from a distance and mistook them for standing pyramids (Ball 1939:206).

The most logical interpretation of Herodotus' representation of these Fayoumi colossi and pyramids is that he confused the details of oral reports pertaining to the presence of two pyramids, and of two partially immersed colossi. If it is assumed that he never entered the Fayoum himself and only wrote his account in the first person to add continuity to narrative tale then it is easy to see how such mistake could occur.

Herodotus testifies to the popularity of the Fayoum's crocodile temples for this period.

> Now for some of the Egyptians the crocodiles are sacred animals, and for others not so, but they treat them on the contrary as enemies: those however who dwell about Thebes and about the lake of Moiris hold them to be most sacred, and each of these two peoples keeps one crocodile selected from the whole number, which has been trained to tameness, and they put hanging ornaments of molten stone and of gold into the ears of these and anklets round the front feet, and they give them food appointed and victims of sacrifices and treat them as well as possible while they live, and after they are dead they bury them in sacred tombs, embalming them: but those who dwell about the city of Elephantine even eat them, not holding them to be sacred. (Herodotus 1910:38)

CHAPTER 6
IRRIGATION AND THE FAYOUM: THE PTOLEMAIC PERIOD

> The Ptolemies treated Egypt as their territorial centre, not as a province; they exploited traditional beliefs to their own advantage and encouraged an at least partially successful Egypto-Greek symbiosis which eased the problems of internal cultural heterogeneity.
> ---David O'Connor

With the death of Alexander the Great, there was a scramble for the reigns of power in the newly conquered eastern lands. The rule of Egypt fell to the General Ptolemy Soter (son of Lagus), the first of the long line of Ptolemies. In the 300 years from Ptolemais I to the fall of the Ptolemies with Cleopatra, the Fayoumi countryside and irrigation infrastructure underwent a number of sweeping changes. Primarily these were (1) rebuilding the decayed infrastructure, (2) building new irrigation structures (dams, canals, dikes, etc.), (3) reclaiming new desert lands.

The Hellenic empire stretched from Macedonia to Persia, and found new administrative problems and circumstances in each of the occupied countries. In Syria there were the problems of control and maintenance of power and political legitimacy. In Persia and Libya there were the problems of the core retaining control over peripheral frontiers. In

Egypt the Ptolemies found many of the same hydro-managerial problems that had faced their Pharaonic and Persian predecessors, though the Greeks had new technologies and skills of engineering with which to face these problems. The Greek administration of Egypt was economically based on the export of agricultural commodities. The new management philosophy was one that can be summed up as: "Egypt was turned into a money making machine; its administration and economy were not so much revolutionized as tightened up" (Davis & Kraay 1973:154).

The initial problems facing the Ptolemies in the Fayoum were the badly neglected irrigation canals and dikes which they inherited from the Ethiopians, Assyrians and Persians. The Ptolemies recognized early on that substantial agricultural returns would be achieved by extensive state level restructuring of the Fayoum's irrigation system. The Fayoum was a source of new lands for Egypt's closed agricultural system, in this it was an exceptional resource. The Ptolemaic Greek and later Roman empires expanded throughout the circum-mediterranean region largely by agriculturally developing "second-class" lands (cf. Goody 1990; E. L. Jones 1987; Duncan-Jones 1990; Butzer 1960). Jack Goody recognized basic differences between Roman expansionism in Europe and North Africa, where Europe was an "open" frontier,

> Egypt. . .was virtually closed, for the Nile valley did not even provide the option of second-class land that

> could be exploited by additional children; there was the irrigated land on the one side and the desert on the other. (Goody 1990:331)

In the closed-nonexpandable environment of Egypt, the Fayoum had a special role in meeting the needs of the expanding, centralized Ptolemaic state. For the Ptolemies and Romans, the Fayoum basin was the most important region of additional exploitable lands, but the lands of the Fayoum required the labors of reclamation and maintenance for its profits to be realized. Once the state overhauled the infrastructure the agricultural production proved it to be anything but a second-class land.

Work and the State's Irrigation Works

It was the Ptolemies who introduced perennial irrigation to the Fayoum. It was not until the nineteenth century that any other region of Egypt was able to again implement any degree of year round irrigation. Under the Ptolemies the Fayoum underwent significant land reclamation (Topel 1973).[1]

The Fayoum contains the archaeological remnants of over a dozen Ptolemaic cities(see map 5.1). Philadelphia, the original city of brotherly love, (so named because its founder Ptolemy II married his sister Arsinoe II) lies in ruins to the northeast. Tebtunis in the south has revealed more Greek and Roman papyrus than any other city in the ancient world. The cities of Karanis and Soknopeau Nesos

(Dimea) located to the north and west of Lake Qarun are the most thoroughly excavated of the Ptolemaic cities.

The Ptolemies exploited the Fayoum's natural slope of land to transport irrigation water long distances in canals, and only used the newly introduced saqiya (norea) animal driven pump to raise the water directly from the canals to field levels. The saqiya provided the important technological edge of easily lifting irrigation water to the height of the surrounding fields. There is much that is missing in the history of the saqiya. It has been assumed that it "originated in Egypt in the third century B.C. and spread rapidly over the Middle East" (Hill 1984:139).

Ptolemy II reclaimed large tracts of land surrounding Lake Moeris by preventing Nile waters from entering the depression. These fertile lake bed soils became a prime agricultural resource of the empire. The largest portion of these reclaimed lands were turned over to the empire's mercenary soldiers.

Regardless of the exact nature of the Dynastic al-lahun embankment (see above Dynastic section), the Ptolemies used this embankment to regulate and reduce water flows into the Fayoum.

> The Lahun Embankment was modified during the reigns of Ptolemy I and II (323-246 B.C.). The annual influx of Nile flood water was thereby diverted, the level of Birket Qarun dropped to below -5 m, and the reclaimed land was colonialized by Macedonian soldiers. Accordingly, most Ptolemaic and early Roman settlements

> occur slightly below or above sea level whereas Middle Kingdom sites occur above 15 m. (Mehringer et al. 1979:240-241)

Ball estimated that this action reduced the size of the lake from about 2,100 square kilometers to a size of only 970 square kilometers, thus adding an increased 1,200 square kilometers of farm lands to the Fayoum (Ball 1939:214-215).

The labor and engineering used in the construction of these canals, and embankment refurbishments was provided by the state. It is undeniable that one special ability the state (as an evolutionary form) has over other social entities is its ability to assemble, organize, and exploit large contingents of labor for the construction of public works. Beginning with Ptolemy II, the Ptolemaic rulers,

> pursued increasingly a policy of fostering a permanent, hereditary military class, which, settled upon the land in times of peace, could be quickly mobilized in emergencies. (Lewis 1986:21)

Fayoum papyri record the presence of a state run irrigation system which stored irrigation water for use at a later time. In the division of Themistes (within the Fayoum Depression, see map 5.1) a large water storage system is recorded. The mechanics of the system at Themistes are not fully understood, but it seems that the Ptolemaic retaining walls exploited the topography in much the same way as the Shidmooh walls still standing in a state of ruin between the villages of Shidmooh and Miniet al Het. In fact the Shidmooh Wall may be in the same location of the ancient

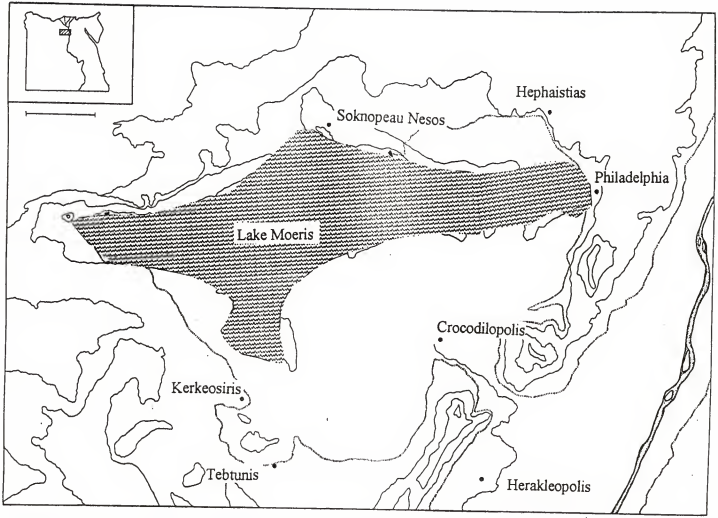

Figure 6-1. Map of Lake Qarun (Moeris) Levels in Ptolemaic Times.

Ptolemaic wall referred to in the "Hamburger Papyrus" (see Johnson 1959:11).

The technique of holding water for later use with retaining walls was also practiced with the aid of the barrage and regulator at the mouth of the Fayoum to the east. Other methods of storing water were also in use. Caton-Thompson's excavations in the desert region north of the Fayoum (between the K. Basin and E channel) also found a large cistern used for the storage of water (Caton-Thompson & Gardner 1934:143). Each water storage method shared the common bond of requiring a sizable work force for their construction and maintenance and some degree of political coordination for their use.

The excavations of Caton-Thompson and Gardner in the late 1920's revealed most of what is known about Ptolemaic land reclamation. Caton-Thompson and Gardner mapped over 16 miles of Ptolemaic irrigation canals in 1928 (Caton-Thompson & Gardner 1934:8). These canals once conveyed water to fields and expansive cities located in what is now once again waterless desert (Caton-Thompson & Gardner 1934:145).

Cross-sections of the canals were excavated. The stratigraphy showed they were cut through Tertiary (marine limestones, shales and sandstones) and Pleistocene (white clays) deposits and then filled with two types of sands after they were abandoned; both "coarse dark yellow drift, or fine white lake sand" (Caton-Thompson & Garner 1934:142).

These sands were deposited through wind action, and little evidence of water born deposits was found. Evidence of ancient crops and agriculture were found along the paths of these ancient canals. There were stumps of ancient date palm trees, as well as vine stems that followed the course of these water ways (Caton-Thompson & Gardner 1934:142).

A large cistern was excavated by Caton-Thompson and Gardner which they estimated to hold approximately 86,000 gallons (Caton-Thompson & Gardner 1934:149). The remains of many vines were found mixed with the sand filling the cistern suggesting that the "surrounding depression had formerly contained a courtyard" (1934:150). At the bottom of the sand filling the cistern were fifteen clay jars typical in form to qawadys (the jars that attach to a Persian-type water wheel). It is on the basis of this find that the saqqiya is thought to have been introduced to Egypt during the time of the Ptolemies.

It is not fully understood how long the desert communities along the edged of the canals between Karanis and Soknopeau Nesos were occupied. There is some evidence that these settlements were inhabited for only a short time.[2] However the settlements of Karanis and Soknopeau Nesos (Dimea) were continuously inhabited for hundreds of years.

Papyrus documents indicate that Dimea had a large irrigation based economy and was extremely agriculturally productive (Caton-Thompson & Gardner 1934:156). Caton-Thompson and Gardner mapped large dikes and canals surrounding the remains of the city, but could find no conclusive evidence for the water supply source.

> With the lake of ever-increasing salinity already below sea-level in the reign of Philadelphus, there seems no likelihood that its waters could have been raised in serviceable quantities over 40 vertical feet in a mile. The only alternative seems to be a fresh water canal from the east connecting ultimately with the Bahr Wardan, such as was postulated by Grenfell and Hunt on the evidence of papyri. (Caton-Thompson & Gardner 1934 156)

Caton-Thompson was convinced that the Wardan canal had been the water source, but Gardner could not accept the idea that ancient engineers overcame the logistical problems involved in moving water sufficient for agriculture by means of 30 miles of desert canals. To this day large portions of the projected canal's route are unknown though this may be partly due to a lack of systematic fieldwork. There is a mild slope of approximately 3.5 inches to the mile from Umm-el-Atel to Dimea, which may have been sufficient if increasingly deeper canals were designed to perpetuate the flow (Caton-Thompson & Gardner 1934:156).

The topography along the route any canal supplying water from the east to Dimea is marked by a small ravine. Gardner and Caton-Thompson searched in vain for the remains of a "high-level canal" or an elevated aqueduct that would have been needed to span the elevation dip of Moeris Bay

(Caton-Thompson & Gardner 1934:156-157). At present the exact location of the canal in this area is problematic.[3]

The desert canal remains which Caton-Thompson mapped in 1927 and 1928 were no longer visible when she conducted an aerial survey in 1931 (1934:157).[4] The fickle nature of the conditions that lead to the visibility of these artifacts offer some hope that the lost portions of the canal will some day become apparent.[5] Available landsat images provide no clue to the route of the desert canal (al-Shaziy et al. 1976).

Greek Mercenaries: Ptolemaic Settlers of the Fayoum

The ethnic composition of Egypt and the Fayoum during Ptolemaic times was anything but homogenous.[6] As mentioned above, the Fayoum became a center for the settlement of Greek mercenaries and their families beginning in the third century B.C. (Crawford 1971:39-41). Families of active soldiers and retired military personnel were allotted land grants. The Ptolemaic policies allowing for the introduction of private land were the first instance of widespread private property in Egypt. This policy had important consequences. Diodorus records that the raw number of villages in the whole of Egypt increased in the 300 year period from the onset of Ptolemaic rule to his visit from 18,000 to 30,000 (Crawford 1971:39-40).

Research by Susan Pomeroy indicates that the women of the Fayoum were culturally different from Ptolemaic women who lived in other regions of Egypt, and offers some correlation between the bureaucratization of the region with these differences. Pomeroy concludes that the Fayoum was the most Hellenized of any of the Egyptian countryside regions. It was a region that adapted the "traditional Greek attitudes that associated land cultivation with men" (Pomeroy 1984:153). Ptolemaic women engaged in agriculture throughout the whole of Egypt, but "it was relatively unusual in the Ptolemaic period for a Greek woman to deal in land in the Fayoum" (Pomeroy 1984:158).

Pomeroy notes that Ester Boserup's demographic theory links women's role in agriculture with centralized bureaucracies.

> Where work is centralized under a bureaucracy and the cultivation of land is intense, requiring that short fallow and agriculture be practiced, the level of woman's participation in farming is low. (Boserup summarized by Pomeroy 1984:155, emphasis added)

If Boserup is correct, women were more Hellenized in the Fayoum than in other Egyptian areas because the land allowed for more centralized forms of agriculture (which could be managed more effectively without women's involvement in agriculture). Ptolemaic rulers recognized that if the Fayoum was to be effectively managed it needed a large labor base. To achieve this end a number of incentives were offered by the state to increase Fayoumi settlement.

The settling of Mercenaries in the Fayoum had clear advantages to the Ptolemy rulers in terms of allegiances gained.

> By inducing experienced foreign soldiers to settle in Egypt Soter could expect their loyalty: they had a stake in their adopted country as well as the means of a permanent livelihood. (Turner 1984:124)

Diodorus gives an account of a Ptolemaic battle (307 B.C.) where the opponent Demetrius was surprised that captured Egyptian mercenaries refused to change allegiances once captured, as was then common practice. The reason for their refusal being that "they had left their gear (aposkeuai) behind in Egypt with Soter" (in Turner 1984:124).

The wives of Greek mercenary soldiers played a vital role in the colonization of the Fayoum. In indigenous Greek society before the fourth century, the bulk of soldiers were simply citizens drawn from the public at large, who came to defend their community in times of need. At that time warfare was infrequent and military duty did little to alter the structure of family/home life. The foreign wars of the late fourth century brought new institutions of professional soldiery (Lacey 1968).

G. T. Griffith (1935) and Sarah Pomeroy document a number of the structural changes brought on by the formation of large mercenary forces. The institutionalization of a mercenary army created a number of problems for Hellenistic administrations. These were problems of shifting alliances;

shifting power bases; problems of food and supplies; and problems of wealth and family management and security during a soldier's absence (de ste Croix 1981).

Ptolemaic laws eventually evolved to allow wives to travel with their soldier husbands. This developed from edicts that originally allowed "dancing girls" to accompany troops in their campaigns (Pomeroy 1984:99). With time, the allowance of women to travel with troops was expanded to accompany family members. Even Alexander's campaigns included the accompaniment of wives, courtesans and concubines (Pomeroy 1984:99).

> The typical Hellenistic soldier was a professional granting allegiance and service to a commander for a price. Without conflicting loyalties to country, kinsmen, or political party, his family and personal possessions assumed paramount importance. Considering the army itself as his home, the mercenary lived like a nomad, bringing his family and all his material property with him wherever he went. (Pomeroy 1984:100)

There were problems of priorities inherent in running an army with its sword and shield in one hand and the tether to its family and livestock in the other.[7]

The Ptolemaic State and Religion

The Ptolemaic state was actively involved in Egyptian religion. The Ptolemaic regimes in the Fayoum cynically manipulated the indigenous ideology, as Wittfogel put it, the Ptolemies "quickly learned to combine religious and secular authority" (1957:94). It is impossible to meaningfully separate the Ptolemaic priests and temples from the Ptolemaic state (Thompson 1990). The indigenous glorification of the state and the accompanying deification of administrators was adopted for the purposes of the Greek foreign power. As one historian put it: "It is hard to gauge the sincerity of feeling evoked by Greek private worship" (E. Turner 1984:169).

In Dynastic times, the different Nomes had independently developed minor cults honoring local deities (David 1982; Kees:1961). Many animals (the crocodile, hippopotamus, or asp for example) were admired and worshiped in one nome while at the same time being seen as objects of scorn or disgust in another. While the crocodile was abhorred in other regions, in the swampy Fayoum it was worshiped at unprecedented levels.[8]

The crocodile temples of the Fayoum demonstrate the strong-centralized nature of the Ptolemaic state. The most complete crocodile temple (in reconstructed form) is the Ptolemaic Qasr Sagah, located in what was once a lush expanse of irrigated green fields, (and now a desert waste) a few miles inland from the South-Eastern shore of modern Lake Qarun. The temple's design is imposing. All attention inside the temple is focused toward the central alter which once contained a mummified crocodile that was a source of oracles (for a fee) to visitors. There is a maze of passageways which wind behind the walls of the temple, to the roof, and even to a secret chamber beneath the alter where a priest sat and provided the voice for the mummified crocodile. The priests of these temples were government employees, whose preachings and oracles are recorded again and again to be in the best interests of the Ptolemaic administrations they served.[9] Turner's analysis shows that state-temples played an important role in the everyday life of the Ptolemaic Fayoumi.

> Both in their shrines, and in their progresses across the waters, the gods of Egypt gave answers to simple enquiries about every day courses of action: 'if it is profitable for me to plough the bank of the lake this year, year thirty-three, and not to sow, extract this enquiry' so runs a request written in demotic Egyptian submitted in the second century to Sobekh (Souchos), the crocodile god of Socnopaei Nesus; submitted alongside it was its pair, the same question formulated as a negative, 'if it is profitable for me not to plough, etc.'. The matched slips of papyrus for this oracle were inserted into an urn, and one was drawn out as if it were a lottery ticket (the bean oracle at Delphi worked on a similar system). Such questions were asked about an intended journey, a purchase or lease, the expectation of return of an absent member of the family. (E. Turner 1984:169)

Ptolemaic priests were a powerful and wealthy segment of society. Their control of resources and power was not limited to the spiritual world alone. Besides the lands their temples owned, they held private property and generated significant personal income through the functions of their priestly offices:

> There is extensive buying, selling and even leasing of <u>hrw n s'nh</u>, "days of endowment," by which the buyer or lessee agrees to fulfill whatever liturgical responsibilities there are in exchange for the income that goes with it. The income is sometimes expressed

> in days per month, sometimes as a percentage of the total number of days. (Johnson 1986:78)

Theban documents record that the Cult of the Dead created income for lector priests who conducted burial services and were responsible for maintaining the funerary chapels (Johnson 1978:78).

> It is likely that control of priestly offices produced a direct increase in wealth and that wealthy families therefore tried to control such offices. (Johnson 1986:81)

The End of the Ptolemies

The general restoration of order under Ptolemy VI (163-145 B.C.) brought a short rebirth of and economic prosperity to Soknopeau Nesos, but during the rule of Ptolemy VII, areas of new settlement and resettlement were again abandoned. Around 50 B.C. the political forces in Egypt were divided by the power struggles of Cleopatra VII and her brother Ptolemy XII.

No archaeological or direct textual evidence has been uncovered indicating why Soknopeau Nesos and other desert cities of the Fayoum were abandoned. Boak recognized that "<u>a breakdown in the irrigation system would be enough to force the bulk of the population to abandon</u> [Soknopeau Nesos]"(1935:20 emphasis added).[10] The present condition of this city leaves no room to doubt that this was the case. Soknopeau Nesos is now miles inland from any water and all but its highest temple walls have been covered by desert sands.

Summary and Conclusions

The early Ptolemies rebuilt the Fayoum's decaying irrigation infrastructure and constructed new canals, dams, and dikes and reclaimed new desert lands. This was accomplished through the labors of their mercenary army whose loyalty was captured through lucrative homestead proclamations.

Though Ptolemaic administrators were primarily concerned with agricultural production, they were not adverse to using ideological means to further this end. The Ptolemies adapted the indigenous system of religious ideology for their own political and economic ends. The state run agricultural system worked hand in hand with the state's franchise on religion.

The lesson of the Ptolemaic period is a simple one: as long as a centralized state could maintain irrigation works (by re-investing taxes in maintenance) the Fayoum was an extraordinarily productive region. When Ptolemaic administrations neglected the maintenance of the Fayoum's irrigation, disastrous results followed.

As we will see, this basic lesson of the Ptolemaic period is based on longstanding principles of requisite maintenance which have not changed in the last two thousand years. The necessity of such maintenance is an inherent (though apparently not always obvious) feature of the Fayoum's irrigation. Administrations which followed the

Ptolemies have been forced to relearn the importance of irrigation maintenance.

Notes

1. The earliest year of reclamation which I have a citation for is 259 B.C. (Turner 1984:144).

2. Caton-Thompson & Gardner conclude that,

> The numismatic evidence suggests that the occupation of the homestead was somewhat transitory... The fact that coins of later date were not discovered in connection with the irrigation system, is suggestive, I think, that this outlying area of cultivation, due possibly to the initiative of Zenon, was an experiment which failed and it reverted to desert before the accession of Euergetes. (Caton-Thompson & Gardner 1934:152)

3. I have scanned the surface for any such remains but have found nothing. Given the lengths that villagers will go to, to take and recycle cut stone as building materials, it is possible such stones were looted centuries ago. Until there is some excavating done in this area, too little is now known to dismiss the possibility of such a canal's existence. But, even without the identification of this crucial canal section, we do know that large amounts of irrigation water were transported via <u>some</u> canal route as far as Soknopeau Nesos.

4. The Classical historian O. Crawford began a tirade of public attacks against Caton-Thompson and Gardner after their attempts to map the ancient canals with aerial survey's failed. A small battle of words appeared in <u>The Times</u> of London, between Crawford and both Caton-Thompson and Gardner. Crawford insisted that the British team had "lost" the perfect opportunity to solve a wealth of problems "as old as the age of Herodotus" (see <u>The Times</u> of London, April 20, 1928; April 21, 1928 and May 10, 1928).

5. My initial inquiries into the matter of hiring a plane to fly over the area were met with the usual levels of Egyptian bureaucratic paranoia. The presence of a large Egyptian Air Force base located in the desert to the north of this region makes the organization of any casual investigation impossible. It would be helpful it the Egyptian Air Force could be alerted to the nature of this inquiry and would periodically report any developments in this quandary.

6. Jews were a significant minority group in Egypt and Fayoumi populations during this period (Goudriaan 1988).

> There were many jews in the Fayyum, where some at least settled in early Ptolemaic times. There was a village called Samaria, doubtless a Samaritan colony, in the south-west of the nome, and we hear of jews in several villages and of a synagogue at Alexandrou Nesos, far from the capital, in the western division- at Arsinoe itself. . . .(Bell 1953:35)

7. Susan Pomeroy notes that the mercenaries' mobile wealth and their families were referred to as "those in the baggage" (hoi en te aposkeue). Aposkeue (baggage), later became narrowed in its meaning to refer not just to a family, but only a wife. Ptolemy I, settled families of his mercenaries in Egypt to overcome these problems of conflicting loyalties and to encourage them to think of Egypt as their home not an outpost in an occupied land.

8. The origins of crocodile worship in the Fayoum are said to go back to the earliest of Dynastic times when King Menes was rescued from fierce hunting dogs that turned on him while hunting in the marshes. At the location of his deliverance Menes is reported to have offered a sacrifice and later built a temple. At least three major temples were erected to Sobek throughout the region.

9. Excavators have also reconstructed both a Ptolemaic and Roman crocodile temple at Karanis. This temple is similar in its layout to the other crocodile temples in Tebtunis, Qasr Qarun, Kerkeosiris and Soknopeau Nesos. After entering the temple through a series of chambers, worshipers made their way to the back of the temple where the crocodile alter was located. As Herodotus reports--though no doubt these are second or third hand reports--these temples often had adjoining ponds containing crocodiles that were ceremonially fed by temple priests.

10. Hobson suggests that the collapse of Soknopeau Nesos may have instead occurred because its non-agrarian orientation did not fit in with the new Roman agro-economic program (Hobson 1984 & 1985).

CHAPTER 7
IRRIGATION AND THE FAYOUM: THE ROMAN PERIOD

> The Fayoum not only shared in the general decline of Egypt, but owing to its peculiar dependence on careful methods of irrigation suffered greater encroachments from the desert than the other nomes in the Nile Valley. ---B. Grenfell

The Roman Fayoum: The New Roman Breadbasket

The addition of Egypt to the holdings of the Roman empire was of crucial importance to the Roman imperial tax base and the stocking of the Roman grain larder. As one historian dryly put it; "approximately 800,000 km2 were added to the empire with the bite of an asp, of which only about 20,000 km2 were cultivated or cultivable" (Parassoglou 1972:2).[1] Twenty thousand square kilometers may appear to be a small concern for an Empire stretching across Europe to the Middle East, but considering the high yields of this acreage, its value cannot easily be under estimated. Josephus reported that for an average year, Egypt shipped over 135,000 tons of wheat to Rome, accounting for about a third of the wheat consumed there (Cited in Lewis 1983:165).

Just as the value of Egypt to the Roman Empire should not be underestimated, the economic value of the Fayoum should not be discounted. Though the land mass of the Fayoum is less than 1% of the land in Egypt, even during

Ptolemaic and Roman times its fields made up approximately 12% of Egyptian cultivated lands.[2] When this calculation is coupled with the period's perennial irrigation practices, then a higher yield can be calculated at rates closer to a quarter of Egypt's agricultural output. The Fayoum had between 1,500 and 2,000 square kilometers of cultivated land during the Roman period (cf. Lewis 1983:107; Parassoglou 1972:117). This is an especially impressive figure when one considers that in 1880 the Fayoum only had 1,230 square kilometers of cultivated land (Johnson 1959:7) and today only 1,519 square kilometers are cultivated (el-Quosy & el-Guindi 1981). The use of new water lifting technologies and intensive managerial controls brought more area under cultivation during the Roman period than is farmed today.

As with most of the data from this far back in time our information is fragmentary, but for the area north of Lake Moeris we know that nearly a third of the lands kept in grain were privately owned (Parassoglou 1972:94-96). From the village of Theadelphia in the Fayoum we have some figures (taken from tax data) on the <u>ousiake ge</u> land use:

Wheat	38%
Barley	5%
Grass for cutting	6%
Grass for grazing	31%
Beans	4%
Vegetable Seed	6%
Lentils	10% [3]

The tax system of the Roman empire required all Fayoumi villages to grow grains for export. Those cities which could not satisfy the state's grain requirements were threatened with collapse. As Hobson put it,

> the relentless Roman system of taxation was based on the premise that every Egyptian village was capable of providing wheat for Rome, and those villages like Soknopaiou Nesos which were not agriculturally productive were ultimately not able to survive in such a system. (Hobson 1984:108)

Grains harvested in the Fayoum were transported on barges via canals to the Nile where they were then ferried to Alexandria and elsewhere in the empire (Johnson 1959:400). Grain ships sailed in fleets from Egypt to Rome in Late Spring or early summer. The length of the time for this journey is not known for sure. Pliny records the journey taking him only nine days, but a more reasonable figure of about three weeks for grain shipments has been reconstructed by the historian Duncan-Jones (1990:16-17).

The Fayoum's marshes also produced large quantities of paper (papyrus) for export to other regions of the empire (Johnson 1959:329-330; Greene 1986).[4] Almost every commodity produced in the Fayoum was taxed and controlled through the allocation of state franchises, which included: olive oil presses, beer, wine, bricks, papyrus, mills, even the rights to hunt or fish (see Johnson 1959:325-480; Wallace 1938).

The most important change for all Egypt at the onset of the Roman occupation was the introduction of widespread private land ownership, and is the feature "most illustrative of the fundamental differences between

Hellenistic and Roman traditions" (Parassoglou 1973:9). Parassoglou notes that the sudden availability of land plots throughout Egypt to Roman citizens created wide spread checker-board patterns of individual land holdings. In fact, this checker-boarding was "most notable in [the Fayoum], for which our information is more complete and where there was a greater concentration of privately owned land than in any other part of Egypt" (Parassoglou 1972:9). Parassoglou believes that by the end of Augustus' reign wide checker-boarding patterns of private land holdings were "the rule rather than the exception" (Parassoglou 1972:9). Several factors contributed to the development of this land fragmentation pattern. Division of land through inheritance, confiscation by the state for back taxes and the idiosyncratic forces of availability of land at the given time of a purchase (Parassoglou 1972:9-11; Wallace 1938; Lewis 1983). Richard Duncan-Jones points out that for all of Egypt, the richest 3.5% of the Roman citizens in Egypt controlled 53% of the land, "while the poorest 47.5% have only 2.8%" (Duncan-Jones 1990:138).

Privatization of Fayoumi lands resulted in the formation of small, intensely farmed agricultural holdings. The perennial irrigation of the Fayoum effectively doubled the agricultural potential of these lands, and effectively doubled the Fayoum's carrying capacity. But the advantages

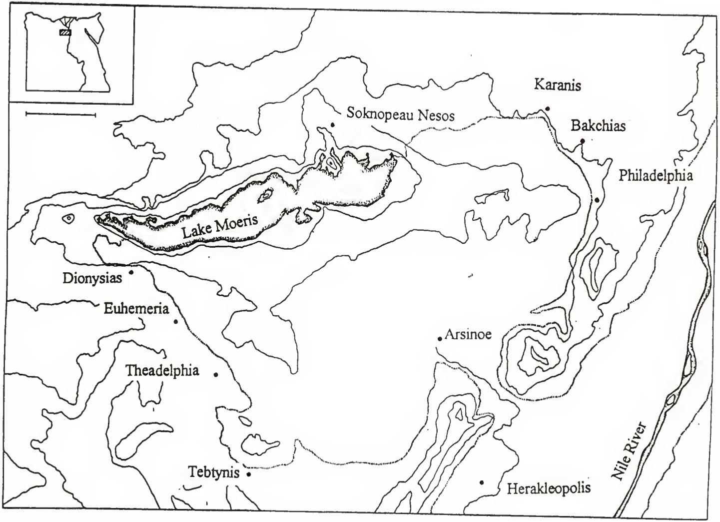

Figure 7-1. Map of Lake Qarun in Roman Times.

of double cropping also contained potential disadvantages, namely the ease with which lands could be waterlogged or over-farmed and rendered useless. Functionally, the institution of private property provided contingencies supporting responsible long-term land use. Property owners would be less likely to over-work land than transient farmers because the contingencies governing their behavior related to long-term instead of short term benefits.
The Ptolemies not only used the labor of its legions to actively reclaim these lands, they also offered incentives to citizens to bring these lands under cultivation. Such incentives included exemptions from taxation for the first three to five years the land was under cultivation (Parassoglou 1972:11). These lands were productive, but they were not deemed capable of growing the grain crops required by the Roman state and were instead planted with olive trees, grapes, and "at the very least it could be sown with grass and used for raising sheep and cattle" (Parassoglou 1972:11).[5]

A variety of documents present evidence of Romans rushing to the Fayoum to lay claim to the fertile lands and creating a frontier boomtown (Wallace 1938; Lewis 1983). Fayoum lands restored by Roman reclamation projects were the vital element in establishing productive Roman plantations and estates. In fact, the neglected irrigation works of the Fayoum reduced the selling price of land there.

> It was here [in the Fayoum] that the inattention to the irrigation system must have created the longest stretches of. . . .land, which was selling at low prices. Moreover, once a beginning was made in this region, it was only natural that later purchases, by the same person or by their relatives or dependents, would tend to take place in the immediate neighborhood. (Parassoglou 1972:88-89)

The introduction of private property in the Fayoum had a direct impact on patterns of marriage. There was an increase in brother-sister marriage, and there was (possibly) a progressive shift from bridewealth (or brideprice) and dowry (or direct dowry) marriage transactions.

"Checker-boarded" land-fragmentation occurred through the forces of inheritance (pre- and post-mortem) just as it does today. In the modern period parallel-cousin endogamous marriages battle against property fragmentation. During the Roman period in the Fayoum brother-sister incest was used as the ultimate weapon used in fighting land fragmentation.[6]

The desert surrounding the Fayoum was a highway for caravans carrying goods (mainly) to the north and south. Desert watch-stations were manned with guards in an attempt to regulate and tax desert traders and travelers. The desert-edge town of Soknopeou Nesos experienced an increase in private dwellings during the first and second centuries, suggesting increased economic productivity for this region. Hundreds of customs documents have survived from the Soknopeau Nesos region, many of these refer to desert guard outposts that tried to regulate desert traffic (Johnson 1959:600-605).[7]

Roman administrators in Egypt weakened the power held by the priesthood and temples during Ptolemaic times.[8] Temples still occupied positions of power, though their economic base shifted from government subsidies toward the private sector. Consequently there were increases in the priesthood's entrepreneurship.[9] As part of the overall program designed to reduce the power of the priesthood, the Roman state all but eliminated the functionary responsibilities and duties of priests. But the regional requirements of irrigation maintenance was an exception to this trend. In the Fayoum the "only example of the actual service of priests in public duties is the liturgy of sluice-guards at Tebtynis" (Johnson, A. 1959:646-647).

Land grant programs in the Fayoum were offered by Roman administrators. Most of these lands went to Roman citizens, though the development of this region was being encouraged to the extent that land ownership rights were extended to non-Hellenized Egyptians who worked to reclaim new lands (Parassoglou 1972:9). The government encouraged the development and purchasing of these lands by offering "three years of full exemption from taxation and in some instances five more years of partial exemption were offered to the new owner" (Parassoglou 1972:11).

But the governmental regulation and intervention of the Roman period consisted of more "taking" than "giving", a process that once out of control bankrupted the Fayoum. There was no shortage of tax collection and regulation, but the state exported the profits taken from the Fayoum. Too little attention was paid to the maintenance of the Fayoum's fragile system, eventually leading to the widespread abandonment of lands rather than facing the penalties from the state for not meeting the required tax-load. The fiscal demands were intense and the overlords of the empire had such little concern for supervising the system's maintenance that they broke its very back. The taxes were collected but these fees were expatriated back to the core of the Roman Empire, not reinvested into the infrastructure of administering Egypt. Lewis isolated the importance of this cycle in the Fayoum when he wrote,

> Economic distress, aggravated by inexorable fiscal demands, led to wholesale abandonment of cultivation, which in turnincreased the tax burden on that population that remained. (Lewis 1983:107-108)

Each of these elements mentioned by Lewis are examined below.

<u>Aggravated Fiscal Demands</u>

The Roman administrators pushed the general taxation and colonialist administrative policies of the Ptolemies a step further increasing rates of taxation at each stage.[10] New taxes were established on priests (A. Johnson 1959:644), and "Augustus confiscated a part of the land which had belonged to the priesthoods of Egypt" (Wallace 1938:4). A tax on one third of the profits from the raising of pigeon houses was collected (Wallace 1938:69). In the Fayoum a tax of 10 drachmae for every camel was charged each year (Wallace 1938:89). In the Fayoum there were capitation taxes levied on pigs (Wallace 1938:94), dike taxes (1938:140), and for the financing of the "central administration" (1938:135), bath taxes (1938:155). The Fayoum is the only known region where inhabitants during the Roman period continued to pay a "salt tax" established in Ptolemaic times (Wallace 1938:184).

The two forms of taxation under Roman rule were taxation in kind or taxation in coin. Generally speaking lands growing grains were taxed by the state collecting set percentages of harvests, while other crops paid their taxes in money (Wallace 1938:6). The rates of taxation fluctuated throughout the Roman period, but an overall trend of increasing taxes occurred from the first century to the third century. Taxation was possible through the implementation of the Roman cadastre survey. Taxmen known as comogrammateus recorded the varieties and amounts of crops grown in the cadastre record. These records served as the basis for state collection.

The Romans pushed the Egyptian populous to the point of diminishing returns and farmers finally abandoned their lands rather than face the penalties for not providing the tax base. The increased demands were made more in terms of grains than they were in terms of taxation of money:

> Although the amount of grain exacted in tribute from Egypt by Augustus is at least three times as great as that which Hieronymus attributes to Ptolemy Philadelphus, the revenue in money obtained by the Roman conqueror was much less than that which flowed into the treasury of the Greek king. (Wallace 1938:342)

Economic Distress & Abandonment of Cultivation

The crises of the mid-first century forced Fayoumi farmers to abandon their lands and flee from the tax collectors (Johnson 1959:245; Lewis 1983:164-165; Parassoglou 1972:157).

> Egypt was experiencing an economic crisis in the fifties and sixties, a crisis which in part resulted in, and was further aggravated by, some fellahin's decision that it was better to abandon everything, flee and live the life of wild beasts and robbers in the swamps of the Delta, and that was not an alluring prospect; the fact that a number of them preferred such [abandonment] to their daily life is significant. Furthermore, a prefect that received word from Rome that the grain supplies were not up to the imperial expectations, and one who was informed either directly or by hint from a local agent that the palace was not totally satisfied with the revenues of the imperial estates, was apt to employ all means available to himself to rectify the situation, regardless of whether such means might be against tradition or legality, or might even prove to be counterproductive in the long run. (Parassoglou 1972:157)

The practice of land abandonment was long-lived. So many villages were abandoned by peasants that, in 154 A.D., an edict of amnesty was issued as a means of getting the peasantry to return to farms (Johnson 1959:252-253).

> If the biographer Commodus is to be trusted, there may have been a series of low Niles in the latter part of

> the second century. In the third century there is clear evidence of the decline of villages in the northern part of the Fayoum. It remains to be determined whether this decline was general and how much is to be ascribed to the failure of the flood or to the neglect of the system of irrigation. In view of the anarchy of the third century, the latter is the more probable, though not necessarily the only explanation. (Johnson, A 1959:vi)

Widespread land abandonment occurred because of the harsh penalties enacted by Roman tax-collectors for failure to pay assessed taxes. The first century Jewish writer Philo, recorded many of the cruel practices of tax-collectors. Tax-collectors often had well equipped torture chambers with "racks and wheels" and "newly invented devices of death" (Philo in Rostovzeff 1929:354). If a farmer fled without his family, his family in turn is reported to have been kept as collateral and often tortured to death (Rostovtzeff 1929:354). In cases "where there were no relatives left, the cruelty was visited upon the friends and neighbors of the fugitives" (Philo quoted in Rostovzeff 1929:355).

Even death was not a means of escaping unpaid taxes. As if to combine the final certitude of death and taxes, the bodies of those who died at the hand of the tax collector were not allowed burials. This was done as a means of "making those who through ties of blood or friendship were closely connected with them feel pity to them and so induce them to pay a ransom for the bodies thus doing them the last service in their power" (Philo directly quoted in Rostovtzeff 1929:354).

The practice of exposing the bodies of individuals who died in debt to the state may have carried a meaning beyond that of simply the religious denying last rights of an individual. Clearly the religious values of this time demanded that individuals were to be buried, but in addition to this there are suggestions of practices akin to "ancestor worship" in the Fayoum. The bodies of family members were often mummified, decorated with lifelike portraits of the deceased and kept in the living room of decedents (Arjona 1978; Petrie 1911).

There are a number of indications of increasing hard times and declining standards of living with the coming of the Roman administrators. Records of Roman period pawn shops in the Fayoum show them to be mostly frequented by women hawking jewelry and household items (Johnson 1959:458-459). Documents record an increase in child exposure (infanticide), indicating changes in labor demands that are best interpreted as related to new levels of "hardship."

> Although the Greeks had long practiced child exposure, in Egypt it was under Roman rather than Greek domination that the practice appears. If this change is not simply an artifact of the haphazard preservation of papyri, then an explanation must be sought. Surely the exposure of infants is a symptom of increased hardship for some residents in Egypt under the Romans. (Pomeroy 1984:139)

It is interesting to note that this was the economic setting in which the first monastic christian movements developed. The early monks who lived alone in Egypt's desert caves may have been escaping the Roman taxman as much as they were fleeing trappings of the material world. The various monastic movements in early christianity (in both Europe and North Africa) were each in some way reactions to the wealth and power of the state (though in Europe these movements developed as reactions to welding of a corrupt state-church that initially viewed monasticism as a threat to their power). Whether or not a direct link can be established between the widespread abandonment of lands, and the actions of such early Egyptian christian monks as Paul the Hermit or St. Anthony (in ca. 275 A.D.), there was surely a sympathetic reaction among the peasants undergoing such hardships toward these monks who rejected the material world that happened to be run by the Roman state.[11]

Increased Tax Burden

The collapse of this disastrous process of over-taxation came at the end of the second century when Egypt's "middle-class" was wiped out with the introduction of a "crown-tax" (Wallace 1938:351).[12]

> The rich booty in cash from the crown-tax. . .seems to have been a factor in the neglect of ordinary sources of revenue and to have led to the abandonment of parts of the system of dikes and canals with attendant deterioration of cultivable land. From this decline in agriculture, despite the valiant efforts of Aurelian

> and Probus to restore the irrigation system, Egypt never fully recovered. (Wallace 1938:284, emphasis added)

The peasants of the Fayoum were taxed at higher rates than other Egyptian peasants through the rationalization that,

> the Fayoum was rich and that the development of that region had received the special care of the Ptolemies and probably the Roman government. The peasants of the Arsinoite nome had therefore, to pay heavily for benefits received, as usual more heavily than the natives elsewhere in Egypt. (Wallace 1938:143)

Roman Administered Fayoumi Irrigation

The irrigation system of the Fayoum had all but collapsed under the late Ptolemies and needed widespread, laborious repairs and reclamation when the Romans began their administrative control of Egypt. This work in the Fayoum was financed through the introduction of a new "capitation tax" (Wallace 1938:143).

Octavian was determined to increase the amount of reclaimed desert land surrounding the Fayoum to their past productiveness. Octavian's motivates for reclaiming desert lands in the Fayoum had more to do with Rome than Egypt. His plan was to turn the Fayoum into a Granary for the city of Rome. Using his soldiers as laborers, he began renovations by first repairing the dikes and canals neglected under the later Ptolemy's administration. Octavian's efforts were more concerned with restoring the waterways that served the depression proper than with the reclaimed lands surrounding the depression.

Initially, the Roman administration put a great effort into reclaiming the Fayoum's neglected system, though a century later careless upkeep again threatened the productivity of the region.

> In the Arsinoite, [the Fayoum] for example, which was and still is the pride and problem of Egypt, the irrigation system was in a deplorable state of inattention, and the desert had reclaimed much of the land that more energetic and thoughtful Ptolemies had wrestled from it. Augustus did employ his legions in the demeaning task of cleaning the canals there and elsewhere in Egypt, but there remained the more arduous toil of reclaiming the land. (Parassoglou 1972:10-11)

The fact that Augustus chose to use his legions rather than the labor of the local peasants demonstrates the importance of this maintenance work for the functioning of the Fayoum's agriculture.

The Fayoum's renewed productivity was apparent as early as 25 A.D. when the Greek geographer and Historian Strabo journeyed to Egypt with the Roman perfect Aelius Gallus. Strabo depicted the Fayoum as a region filled with a greater abundance of crops than any other nome of Egypt. The Fayoum produced corn (wheat) for loaves of bread, olives used for oil, and grapes that provided "wine in no small quantity." He describes Lake Moeris as,

> Sufficient to bear the flood-tides at the rising of the Nile and not overflow into the inhabited and planted parts, and then in the retirement of the river, to return the excess water to the river by the same canal at each of its two mouths.[13] (Strabo 1917:103)

The level of Lake Moeris [predecessor to Lake Qarun] fell to new lows as a result of Roman reclamation projects. The lake was at an elevation of about 7 meters below sea level when Rome began its administration of Egypt, and further fell to an elevation of at least -20 meters by the Late Roman Period (Ball 1939:218-219; Mehringer et al. 1979:240).[14] Ball concluded that the diminishing of Late Roman Period lake levels were simply the result of canal maintenance neglect rather than an engineered accomplishment. These low lake levels could,

> only have been caused by a further diminution of the annual influx of Nile water into it, such as would result from a gradual silting up of the canal by which the water entered the depression; and there seems reason to think that such a silting-up may have taken place during the decline of Roman power in the third century A.D. (Ball 1939:219)

Numerous water storage works were built during the Roman period. These include both irrigation and potable storage works. Cisterns have been found at Tebtunis (Anti 1931) and Kom Talit in the southern Fayoum (Bernard 1981; Arnold 1966) and Karanis, and Philadephius in the north. Records of irrigation water storage refer to such works in the region of Themistes.

Papyrus documents record transactions and complaints concerning the distribution of irrigation water to regional governmental figures. There is documentary evidence of the irrigation of summer crops in the Division of Themistes (in the south-central Fayoum).

> Theon, guard of the shore, to Claudius Erasus, strategus of the division of Themistes, greeting. The gates of the [sluice], as you know, were lifted when you were present as much as the inspectors of sowing wished, and they are nearly all out of water, as you know; for I gave the inspectors of sowing the conduct of the whole matter, instructing them through you to draw off as much water as they needed; and I urged you through the centurion Iulius. . . .I hear that the comogrammateus of Apias has petitioned you for a further supply of water for the fields of the village, when all the time the inspector of sowing for the district (?) was at the village and ought , if he required water, to have remembered my order, given when you were present, to come up in order to draw off as much water as he wished or to send somebody for this purpose. It is evident from this that nobody wants it, nor has any one of the cultivators applied to you about this till now. (from P. Roy 81, ca. A.D. 104,: Johnson 1959:20)

This passage demonstrates a number of features relating to Roman irrigation in the Fayoum. First, the ability and role of the state to regulate irrigation. Secondly, it refers to set sluice gates whose openings are directly tied to specific land rights. Thirdly, individuals could negotiate with other irrigators to trade or exchange irrigating times to suit particular cropping or logistical conditions.

From this we can conclude that the state was (like today) responsible for the delivery of water, and it had a moderating role in irrigation activities and water disputes. This document clarifies the role of the state as the primary arena for airing disputes and violations of water contracts. Likewise the upkeep of canals and sluice gates are also demonstrated to be the responsibility of the state. Unfortunately, no documents have been found that reveal the specific methods of allocating water shares for this period, so there are still many questions concerning issues related to conveyance loss that are left unanswered.

Throughout Egypt the Roman state demanded that farmers' provide five days a year of "corvee" labor for canal maintenance (Keenan 1969; Lewis 1983:112), though in Upper Egypt the labor due was measured by "a specified amount of earth thrown up on the embankments" (Wallace 1938:142). It is possible that the inhabitants of the Fayoum were required to work more than the annual five days demanded in the other nomes.

> The corvee in the Fayoum, since work on the dikes in that nome was especially important, was systematized by the Ptolemies or by the Roman administration into the [required dike maintenance labor]. All [normally productive lands] were liable to the corvee. (Wallace 1938:143)

The Fayoum's canals needed to be cleaned before and after each inundation, while dikes needed continual attention before, after and during each flood (Rathbone 1991:225).

There are other aspects of the irrigation system for which it is not clear whether responsibilities lay with the state or with families.

> The provision and maintenance of irrigating machines is one of the most regularly recurring items of expense in estate accounts. Both shadufs and sakiyehs appear to me mentioned. Who is responsible for the actual operation is less clear. In one case we hear of a special remission to the peasants outside the gate because they 'are to do the irrigation into the

> orchards and fields from their own property instead of [having it done by] the estate oxen of the glorious house.' (Hardy 1931:114-115 emphasis added)

A wealth of documentary evidence indicates that water wheels were extensively used year round to such a degree that "repairs to water-wheels date from almost every month of the year" (Rathbone 1991:223 & 260-263).

Some of the published land leases from the Roman Fayoum specify the rights and duties of parties leasing agricultural lands. The types of crops are specified and the specific maintenance duties are clearly outlined. The irrigation responsibilities to those granted leases were often clearly specified in such documents. Leasees were often required to maintain,

> the irrigation and dike system and assuming the supervision of the green crops. . . .and the lessees will perform each year at the right time all the work on the allotment, viz. the requisite work on the dike and irrigation systems and in weeding all the other agricultural tasks, and will cause no damage. . .At the expiration of the period the lessees will surrender the allotment free from rushes, coarse grass, and all dirt, with the Egyptian reeds cut and the canals built up. (Browne 1967:7)

Over 100 kilometers of canals were dug along the depression's eastern and northern edges to provide water for the cities of Philadelphia, Bacchias, Karanis and Soknopeau Nesos. Papyrus documents of the period record many irrigation related government positions including: irrigation overseers, irrigation superintendents, water-guards, embankment, public work inspectors and river-workers, (see Johnson 1959:15-25). These laborers known as "river-workmen" (potamitai) were such an integral part of the economy that they had their own workers guild, and worked at a fixed rate of pay (Johnson 1959:25; Hardy 1931:114). Rathbone indicates that during the second and third centuries these river-workmen worked independently of the Roman state and traveled from estate to estate looking for work.

> They seem to have been completely independent of the estate, working in itinerant bands, and their employment was therefore arranged by the central administration of the estate. (Rathbone 1991:166)

This privatization of some canal maintenance responsibilities seems to be in part responsible for the coming collapse of the Fayoum's irrigation networks.

There are a wealth of Fayoumi receipts from earlier periods for irrigation maintenance activities required by the state (Pearl 1951; Keenan 1969).

> In the first century we hear little about liturgies. The earliest receipt for the imposition of five days' labor on canals and embankments is dated in A. D. 49 though the requirement may have existed earlier. (Johnson 1959:609)

During the later first and early second centuries, receipts for such duties become more common. Typically such receipts name the individual and list the maintenance obligations he has satisfied. Below is an example of a typical receipt:

> The ninth year of the Emperor Caesar Nerva Trajan Augustus Germanicus Daccicus. Has worked in the month of Pauni in fulfillment of his obligation of the same ninth year for work on the embankments, (2nd hand) in the new six-gate sluice from Pauni 18 to 22, on behalf

> of Karanis, Ptollis, son of Pamesnes, grandson of Tithoeis, whose mother is Tanephremmis. I, Isidoros, have signed. (Pearl 1951:223)

These receipts were apparently issued to individuals as proof of having completed their obligation to the state. The "six-gate sluice" referred to in the above receipt probably refers to the main water regulator located along the Hawara and al-Lahun Gap (Pearl 1951:228-230). If this is the case, it would indicate that laborers were imported from other regions to work on this central component of Fayoum irrigation.

Local Water Lifting Problems and Solutions

A number of hydrological innovations were introduced to the Fayoum in the Roman period. Ox-driven water wheels (norea) were used to lift water, and there is a single surviving reference to some sort of "siphon" (diabetes)--possibly a Ctesibian pump--being used (Rathbone 1991:222). These water lifting devices were primarily used to fill regional reservoirs, which later distributed the waters. These actions were coordinated by local representatives of the state.

> The water was pumped into reservoirs by a "shaduf' or water-wheel, and distributed to various customers. Most of the sums needed for operating the system were derived from contributions of the magistrates. (Tcherikover & Fuks 1960 Volume 2:221)

There is some evidence that the use of the saqiya (norea) during the Roman period may not have been widespread throughout the socioeconomic spectrum.

> At first saqiyas were a luxury article and were used for water supply and irrigation on the estates of rich men. By about AD 250 they were in use on large estates, but they probably did not come into widespread use for water supply and irrigation until the fourth or fifth century AD, with the introduction of the pawl mechanism and earthenware pots. (Hill 1984:138-139)

The origins of the undershot water-wheel for the Fayoum are not clear and may have occurred during Roman occupation. Some authors haphazardly place the introduction of the Fayoumi undershot waterwheel during Byzantine times, though I am unaware of either documentary or artifactual evidence to support this assertion. In the history of early technology there are always problems with relying on written sources to establish the origin or introduction of specific technologies. The primary problem is that the first literary reference to a technology does not necessarily provide information as to its introduction, it only marks its use from <u>at least</u> that point in time.

We do know that in the first century A. D. Vitruvius described a "water-drum" in use in Europe that was capable of lifting water from river basins up to the height of surrounding fields.

> 10:4 Now I shall explain about the implements that are invented for the lifting of water, how they are made in various sorts. And first I shall speak of the drum. This does not lift the water high, but it pumps out a great amount. An axle made on the lathe or by compasses, with its ends iron-plated, having round it for the rest of its length a drum made of boards bound together, is placed on posts that have iron plates in them under the heads of the axle. In the hollow of its drum are placed eight dividing walls that touch the axle and the farthest round of the drum separating equal compartments of the drum. 2. Round its end are

> fastened lids leaving openings of half a foot (ca. 15 cm) for the water to come in. Also along the axle pigeon-holes are bored into each compartment at one end. It is tarred like a ship; it is turned by treading men; and taking in through the openings that are in the ends of the drum, it gives out through the pigeon-holes along the axle, where a wooden trough is placed with a gutter joined to it. In this way it provides a great amount of water for irrigating gardens or for managing saltpans. (cited in Drachmann 1963:150)

This is not a wheel of the exact same design as those in the Fayoum, (Vitruvius' wheel gathered water at the paddle blades and letting it run into the hub, while modern wheels gather and carry at the wheel-rim) but, the basics of undershot lifting water-wheel mechanics are at least well documented for this period. Pliny also describes a wheel-driven lifting device during Roman times (Butzer et al. 1985:482).

Needham believes that the undershot-wheel may have first been built in India at an undetermined time during the first millennium B.C. and then diffused to the Hellenistic world and later China (Needham 1965:362 cf. Hill 1984:140; Laufer 1933). Reynolds establishes the invention of the vertical undershot waterwheel during the first century B.C. (Reynolds 1983:19-28). Oleson has compiled several sources writing during the first century B. C. who describe various compartmented wheels known through out the Greek and Roman World (Oleson 1984).[15] Clearly such lifting devices were known throughout the Roman world and their use would not be unknown to the rulers of Egypt. Thus the evidence is extensive enough to conclude that the Romans brought the knowledge of such technology with them to the Middle East.[16]

Whenever the undershot-wheel was invented, and whenever it was introduced into Egypt there are peculiarities to its design that make the Fayoum the natural place for its Egyptian florescence. The most important feature is of course its requirement for running water (Hill 1984:140; Schioler 1973). No other region of Egypt has the geographic inclines along its waterways that are required to turn the undershot noria's wheels.

These technological innovations in water lifting techniques helped bring more lands under cultivation at reduced labor costs. The introduction of new water lifting devices created new (technological) maintenance requirements, but compared to the water lifting efforts these technologies replaced, the end result was a reduction of labor output. These technologies may have also reduced the role of the state in some of the Fayoum's irrigation affairs. As we will see in later chapters, in the contemporary Fayoum the introduction of labor-saving hydraulic machinery (i.e. pumps) can have the effect of introducing increased levels of hydraulic independence. With new technologies, one or two people could manipulate quantities of water which would have previously required the labor of a small village.

Upstream and Downstream in the Roman Fayoum

The deterioration and collapse of reclaimed lands in the Fayoum during the Roman occupation provides one of the best proofs of the necessity for state-organized forms of irrigation in this region. The areas that were abandoned during these periods of fiscal crisis were lands requiring the most labor for lifting a supply of water to them. These were the marginal lands of the deserts surrounding the Fayoum Basin to the south, west and north. Entire villages and towns along these desert-edge regions were deserted or at least abandoned to a greater degree than those of the up-canal regions. Plots of land in upstream localities continued to generate enough income for their owners/farmers to survive, while those at the down stream periphery were abandoned.

The reason these regions were deserted at higher rates than the interior is to be found in the costs of both raising water and maintaining the supply waterways. As canal maintenance was ignored, the effects of conveyance loss were accentuated and the most distant plots of land were the most severely effected. As the Roman state lost its control over the upkeep of Fayoumi canals the settlements on the periphery collapsed, many of which have never been resettled.

> [These] lands were largely marginal to begin with, and as they were also the most remote as well as the most elevated above the basin floor, the amount of labour required to get the irrigation water to them was

> disproportionately high. The water channels, lacking maintenance, silted up, the land unreached by the water was perforce left uncultivated, and so the whole vicious cycle recommenced. What man abandoned the desert quickly reclaimed and covered with its blowing sands. (Lewis 1983:108)

There are also suggestions that water theft by those in the up-canal regions of the Fayoum may have played a significant role in the abandonment of Fayoumi villages. Dominic Rathbone notes that one large Fayoumi estate took on the duties of keeping canal-ways open during the fourth century's decaying management but that was not enough to shelter the Appianus estate from the effects of water theft by desperate neighbors.

> Something had to start the downward spiral, and another complaint from Theadelphia points to the probable answer: the <u>inhabitants of lower villages were stealing the vital water from the main feeder canal</u> which had been repaired or improved by Alypios. (Rathbone 1991:408, emphasis added)

The effects of conveyance loss during such times of mismanagement made the difference between survival and the abandonment of land.

The Roman government effected such a strangle-hold of taxation on the Fayoum and Egypt as a whole that the populous was forced to flee from the consequences of not being able to pay taxes. In the Fayoum, the state's reduced ability to provide the service of canal maintenance caused this burden to fall hardest on those out on the agrarian edge.

The End of the Roman Fayoum

Johnson writes that "in the third century many villages in the Fayum were almost completely abandoned though there was a temporary revival towards the end of the century, when political conditions became more stable" (Johnson 1959:246). In part, this regional agro-managerial collapse can be linked to similar disasters occurring throughout the whole of Egypt at this time, but there can be no doubt that the Fayoum,

> owing to its peculiar dependence on careful methods of irrigation suffered greater encroachments from the desert than the other nomes in the Nile Valley. (Grenfell et al. 1900:15, emphasis added)

Many of the Fayoumi lands irrigated and farmed during Ptolemaic and Roman administrations have never been farmed since. The Medieval period in the Fayoum saw a general neglect of irrigation systems, and efforts to reclaim these desert lands in the modern period have been largely unsuccessful.

Summary and Conclusion

Despite the importance of trade, the basis of Egypt's wealth was agriculture, and the success of Egyptian agriculture rested on irrigation. The Roman administration of the Fayoum experienced its greatest prosperity when it directed and mandated the maintenance of irrigation works, and experienced collapse when they let these features fall into disrepair. The reasons for the various periods of neglect varied. At times, the fiscal demands of the greater

Roman empire pressured Egyptian administrators to remit taxes--which might otherwise have been spent on maintenance--to the empire's core. At other times, corruption and miscalculations of the required maintenance brought on hydraulic neglect.

The neglect of irrigation infrastructure combined with the increased levels of taxation had disastrous effects in the Fayoum countryside. The widespread abandonment of farms to escape penalization from tax collectors only tells part of the story.

The later Roman administrations' neglect of hydraulic responsibilities provides us with exceptional evidence for the deleterious effects of conveyance-loss on down-canal communities. The fourth century abandonment of the Fayoum's down-canal villages was clearly because "these villages came at the end of the queue for use of water from the main feeder canals" (Rathbone 1981:221). The general neglect of Fayoumi irrigation works was not to be significantly addressed in the millennium which followed the Roman administration.

Notes

1. The situation can also been seen as one which was to benefit Egypt as much as the Roman empire. As Pomeroy writes,

> Cleopatra's relationship with Julius Caesar and Marc Antony may have been romantic liaisons from the Roman point of view--both these men were notoriously attractive to women-- but from the queen's perspective they were the equivalent of dynastic marriages. Her dowry was Egypt; through her "marriages," she expected to win dominion over the Roman world. (Pomeroy 1984:25)

2. This figure derived by using Parassoglou's (1972:117) figure of 1500 to 2000 square km of cultivated land in the Fayoum, and his calculation (1972:2) of 20,000 square Kilometers of cultivable land for all of Egypt.

3. These figures are extrapolated from Parassoglou 1972:111, Table 9. Area by Crop figures were converted to simple percentages.

4. One record indicates a single transaction for 20,000 stalks of papyrus sold from the Fayoum (Lewis 1983:128-129).

5. The Ptolemies and Romans brought with them their preference for wine over the beers brewed by the local populations. Vast areas of the Fayoum were converted to vineyards by both Ptolemies and Roman, though the reason for this had more to do with the capabilities of the soils, than a cultural predilection for one type of alcohol over an other. The reclaimed soils at the edge of the depression were those most commonly used for viticulture, as they were too depleted to support grains or other crops (see Rostovtzeff 1922:93-95; Parassoglou 1972:11 & 118).

6. Keith Hopkins' 1980 article "Brother-Sister Marriage in Roman Egypt" assimilates data on the high frequency of sibling marriages in the Fayoum and Egypt at large. Brother-sister marriages in Roman Egypt were not considered incestuous and, surprisingly, appears to have regularly occurred among all social strata of the population.

Cross-cultural data indicates that the only other known instances of brother/sister marriage occur among royalty, this makes the Fayoum's widespread marriage among commoners a significant anomaly. Past anthropological explanations of cross-cultural sibling marriages have always emphasized the importance of the siblings' elite status. The classic examples of elite sibling marriage in ethnographic literature concern the culture's of Dynastic Egypt, ancient Persia, Pre-contact Hawaii and the Peruvian Inca Empire. These incestuous marriage patterns have been explained by anthropologists as being a sanctioned form of property/inheritance control for the ruling elite (Bixler 1982).

Bixler maintains that a ruler marrying his sister thus eliminates the spread of wealth and power to persons beyond his immediate clan, and diminishes future fragmentation of the empire in power struggles after his death. Royal Bo-Si marriage does not necessarily imply sexual intercourse between siblings, only the socially recognized marriage of the "parents" of future rulers. As such these marriages provide a lineage and legitimacy for heirs (Bowman 1986; Lewis 1986).

Hopkins' data clearly establishes that sibling marriage occurred throughout all levels of society. Though the overall frequency of brother-sister marriage is not known, there are frequency counts from his data sample.

> In the usable census return, brother-sister marriages account for between 15 and 21 percent of all ongoing marriages (N=113). Crude demographic calculation suggests that in the conditions of high mortality prevalent in Roman Egypt, only about 40 percent of all families had both a son <u>and</u> a daughter or both sons <u>and</u> daughters surviving to marriageable age. (Hopkins 1980:304, emphasis in original)

The majority of the textual evidence (relating to Roman brother/sister marriage) used by Hopkins comes from the Fayoum. Though he admits that very little is known about the social class of the households to whom the survey data refers, he remains convinced that "this source may be unbiased as to social class"(1980:316). The basis for this conclusion is that a quarter of the document's listed the occupations of household heads, and whether or not they held slaves. Eighty one per cent of the households with documents recording brother-sister marriages contained no slaves (Hopkins 1980). This is assumed by Hopkins to mark these as being households of commoners rather than elites. However, this is not a conclusive assumption. The presence of numerous slave taxes during the Roman period would have provided ample reason not to claim the ownership of slaves on cadastre documents (Wallace 1938).

Not only does the practice of brother-sister marriage seem to have been commonplace, but its occurrence was spread across a considerable period of time within single families. Lewis cites a document from A.D. 165 that "shows brother-sister unions in three successive generations of a family of gymnasial status; another of 189, [of] a family that had seven such marriages in four generations" (Lewis 1983:43).

7. The remains of some of these outposts can still be found to in the hills to the south of the ruins of Soknopeau Nesos. Similar outpost remains can also be seen around desert gullies near Silah (to the East of the Fayoum Depression) or Medinet Madi (to the South). Despite the widespread presence of these state facilities it is fair to assume that some degree of smuggling escaped the monitoring of the Roman state.

8. From the extant record of holidays and festivals during the Roman period there comes suggestions of an enormous amount of time devoted to celebrations. During Dynastic times Herodotus observed: "the Egyptians hold a festival not once a year, but they have frequent festivals"(Herodotus in

Lewis 1983:91). Using fragments of several papyri from the Fayoumi village of Soknopaiou Nesos, Naphtali Lewis estimated that over 150 days out of the year were dedicated to celebrating different holidays and deities. He concludes that this is far too much time for any farming society to devote to holidays, therefore "the role of the permanent: the villagers would participate in some rites, and the priesthood would perform the rest in their name" (Lewis 1983:91).

Given what is known about the frequency of religiously sanctioned holidays and festivals in other agrarian societies, it is not necessary to assume religious specialists would be needed simply to celebrate holidays as surrogates for toiling peasants. Peter Laslett's analysis of medieval England records dozens of days a year were holidays on which workers not only had the day off work, but their overlords were required to supply them with appropriate food and drink (Laslett 1971).

9. Johnson writes that,

> Although the power and influence of the priesthood had been greatly weakened by the measures of Augustus, the temples still derived a considerable income from gifts and offerings of devout worshippers. Temples and shrines were rebuilt or repaired at private expense; others were built by towns or by emperors. The Ptolemies gave the income from certain taxes to temples. <u>The Romans continued the taxes but diverted them to the hieratic department of the fiscus</u>. (1959:641-642, emphasis added)

There was a surge in the active role that temple's played in the economy. In the Fayoum markets began to be held in the various cities' centralized temples, and "artisans at Arsinoe were located at various shrines" (Johnson 1959:642). Records from Karanis indicate that "sheep shearers and wool sellers were also attached to the temple" (Johnson 1959:643). The temple at Soknopeau Nesos held the franchise on the operation of fishing boats on Lake Moeris, though it is not clear if it directly ran such ventures or if it sublet these rights (Johnson 1959:655).

Temples were a secure and significant tax base for Roman administrators. In the first half of the second century, the "temple of Soccnopaei Nesus evidently had a revenue in excess of 10,000 dr. annually" though 9,000 dr. of this was paid to the Roman state in taxes (Johnson 1959:644-655). The exceptionally high rates of taxation for priests and temples were clearly "designed to curb the power of the priests by reducing their wealth" (Wallace 1938:253).

Temples paid land taxes at rates comparable to other institutions and individuals (Johnson 1959:640). The temples began paying taxes on the variety of trades--ranging from selling vegetables to manufacturing plaster mummy masks--that occurred under their direction (Johnson 1959:643). Priests and temples were also accountable for a number of taxes peculiar to their profession and duties, including taxes on: sacrificing animals, the use of alters, and other religious activities (see Wallace 1938:238-254; Johnson 1959:639-670).

With the increased privatization of temples, even the specialized religious titles and duties could be bought from the Roman state for a price (Johnson 1959:645). For example, the office of prophet could be purchased with money, the position was at times sold periodically and at times for life (Johnson, A. 1959:653). In Tebtunis the following record of such a sale is preserved:

> Received from Harthotes, son of Harthotes, for the post of prophet and the other offices out of the sum of one talent, after the 1500 dr. agreed upon as payable by himself, in return for which he had been assigned the offices. . . . (Johnson 1959:653)

The title of seer was extremely profitable to those who held it. High fees charged by seers are recorded from the records of all the major Fayoum temples (e.g. Johnson 1959:644). Records from Soknopeou Nesos indicate that one seer received one fifth of the revenue generated by the particular shrine he was affiliated with (Johnson, A. 1959:645).

Many of the Ptolemaic and Dynastic religious practices continued to be practiced, and old deities continued to be worshiped. Strabo recorded the continued importance of crocodile deities during Roman rule. His description of the care and feeding of temple crocodiles at the Arsinoe temple shows small sacrifices of food and wine were given temple crocodiles.

> It is fed with the bread, meat, and wine brought by the strangers who come to see it. Our host went with us to the lake, taking along a small meal-cake, some meat, and a small flask of wine. We found the animal lying on the bank; the priests approached and, while some of them opened their jaws, another thrust first the cake into his mouth, then the meat, and finally poured the wine after them. Thereupon the crocodile plunged into the lake and swam to the opposite shore. (Steindorf & Seele 1942:139)

10. With the coming of the new Roman administrations, the previous Greek populations moved into new positions of subordination alongside the indigenous Egyptians and

minority populations. The recognized ethnicities of Roman Egypt were Romans, Greeks, Jews, Egyptians.

Greeks were allowed to keep some vestiges of their previous citizenship only in the three cities of Alexandria, Naukrratis (Delta) and Ptolemais (Upper Egypt)--and after 130 AD the city of Antinoopolis in Middle Egypt. Citizens of these cities were organized in the classical units of tribes and demes. The actual powers of these Greeks were limited to social rather than political matters. They maintained their previous methods of education and religion, though their conquest left them with virtually none of their previous political and economic power.

The new Roman administration of Egypt also re-established the bulk of (previous) Greek citizens as Egyptians. As Lewis notes the historian Livy recorded the events as an ethnic slur when he wrote "the Macedonians had degenerated to the level of Egyptians" (Livy in Lewis 1983:31). With this proclamation the privileged status and property rights of these families were nothing more than the despised indigenous population. These distinctions were of vital importance until 212 AD when the Emperor Caracalla granted Roman citizenship to all who lived within the Roman empire.

The minorities of the Roman Egypt and the Fayoum include a sizable Jewish population. Alexandria had a large Jewish population. Philo writes in the first century AD that Jews were allowed to keep their own governmental councils of elders, "and that at the very time when the Greek citizens were denied a boule" (Lewis 1983:29). Though Jews were still not allowed membership in the all important polis, their elevated social status over the Greeks lead to a number of hostilities. After the destruction of the temple in Jerusalem in 70 AD, there was a move to establish the temple at Leontopolis (near Memphis) as the central temple of Judaism (Lewis 1983:30) The Roman government perceived this as a threat to their hold on power and they established a special Jewish tax and restricted the rights and powers of Jews. The end result of this series of events was a series of Jewish revolts. In 115 AD a series of raid campaigns began and were conducted throughout the Egyptian countryside until the revolt collapsed in 117 AD. Little is known of exact nature of the revolt in the Fayoum, but the disruption in the Fayoumi village of Sebennytos was so severe that 34 years later that land and canals damaged in the revolt was still damaged beyond use (Tcherikover et al. 1960:257; Wallace 1938:170-176). A document recording tax figures for Karanis records only a single Jewish inhabitant in the year 146. Such a small figure for a town the size of Karanis suggests that the revolt greatly reduced the Jewish population in the Fayoum.

Texts from the Fayoum mention a special Jewish tax in documents from Arsinoe and Karanis (Tcherikover et al.

1957:204; 1964:17), and land records suggest that jewish land holdings were frequent but not sizable (e.g. Tcherikover 1957 vol 1:140-150). Synagogues are recorded for the larger Fayoum cities. A land survey of Arsinoite mentions a synagogue on the outskirts of town (Techerikover 1957 vol 1:247). Names identified as Jewish are frequent in documents of the Fayoum during the Roman period (W Chrest 61:5 cited in Bell 1953:35).

11. For more background on the coevolution of Egyptian christianity and monasticism see: Abbott 1937; Jonas 1958; Kamil 1987; Leeder 1918; Meinardus 1977; Pearson et al. 1986; Scott-Moncrieff 1913; Walters 1974 & 1979; Watkin 1963; Worrell 1945.

12. Other events contributing to the third century managerial collapse of Egypt include; the collapse of Egyptian trade with India (Wallace 1938:351), plagues, and the general northern expansion of the Roman frontier into central Europe. The combined effect of these events however was not enough of a force to account for the administrative demise of Egypt--whose economic contributions (when efficiently administered) were significant enough to justify considerable efforts. The later Roman administrators of Egypt were just not willing to reinvest a significant portion of the tax profits to the upkeep of the system.

13. Strabo was mistaken in his view that the water from the Nile flowed both in and out of the Fayoum. We can assume that Strabo's mistake was simply the result of plagiarizing erroneous passages from Herodotus. As John Ball recognized in 1939, the elevation of Ptolemaic towns was below that of the Mediterranean. The level of the Nile during this period was above its present level thus making it impossible for the flow to travel in the reverse direction (cf. Sanford & Arknell 1929; Ball 1942:60-62; Ball 1939:210-219; Mehringer et al. 1979). Strabo records the use of locks designed by engineers at the mouth of the canal's entrance to the Fayoum to regulate a flow of water both in and out of the depression.

14. These estimates are derived from analysis of Roman period village locations and the depths of excavated wells.

15. For the category of compartmented wheel with compartmented rim Oleson lists: 111 B.C. Philo of Byzantium; 55 B.C. Lucretius; 23 B.C. Vitruviud; 20 B.C. Strabo; 50 A.D. Hero; 218 A.D. Nonius Marcellus (Oleson 1984: 20). Besides this list he also documents textual evidence for a number of other devices which may be of the same design of the Fayoum's under-shot wheels.

16. The implementation of the hollow-rimmed water wheels for lifting irrigation water also occurs in modern times in the Delta. The taabut is designed with a circular water buffalo track mechanism of the standard saqia, but the water is lifted in a vertical hollow-rimmed wheel (Schioler 1973:35). Thorkild Schioler documented the remnants of a hollow-rim water wheel at the ruins of Salhin near Aleppo (Syria). (see also a photograph --plate III C-- in Moussly 1951, Le probleme de l'eau en Syrie). The design of the Fayoumi "box" water-lifting carrier is similar in design to that used in the famous wheel at Hamma (Schioler 1973:37-38).

CHAPTER 8
IRRIGATION AND THE FAYOUM: MEDIEVAL PERIOD

> Certain hydraulic societies evolved into non-hydraulic agrarian societies; but generally they did so in consequence of external aggression and conquest. They experienced a diversive rather than a developmental change. ---Karl Wittfogel

Medieval Overview of the Fayoum

Very little involving irrigation and agriculture in the Fayoum changed during the medieval period. Different administrations came and went, but all were bound by constant threads of varying degrees of neglect and decay of irrigation works. In introducing Mahzumi's 12th century agricultural treatise, Gladys Frantz-Murphy comments that, "elements of the study detailed by Mahzumi were in place as much as 500 years before and 300 years after he wrote" (1986:1).

The Fayoum was the gateway for the invading Islamic armies of Arabia in 639. The Fayoum was conquered by 'Amr with little resistance. There is some evidence that the indigenous coptics and Bedu populations welcomed the armies as co-conspirators against the demands of the Byzantine state. Lapidus notes that during this period the Fayoum was a region from which, "bedouins attacked villages, interfered with communications and the transport of merchandise, and cut off grain shipments to Cairo" (Lapidus 1967:28).

The medieval Fayoum countryside was made up of more than one hundred villages. In the medieval period the villages became a primary focus of agricultural and economic administration (see Abd al-Rahman 1984:237-244). Each village community had a leader known as the shaykh al-balad, most always an individual from the wealthiest of local families. In the personage of the shaykh was the police, judge, tax collector, arbitrator and general liaison to the multazim (Owen 1969:6). He was exempt from taxation, and could exercise his powers as he saw fit so long as he was fully capable of collecting taxes due.

Like many of the previous administrators of Egypt, the early Islamic regimes initially improved the depleted countryside and irrigation works, and even created incentives for reclaiming lands.

> The government also gave guarantors tax concessions for bringing underdeveloped land under cultivation, for the greater the area of cultivated land the larger the tax base. Like the documents, the narrative sources too suggest an expansion of the cultivated area while also providing indirect evidence of an increase in population. (Frantz-Murphy 1984:136)

The establishment of iqta' after the Muslim conquest functioned partially as the mercenary land grants had in the prior times of the Ptolemies and Romans. Instead of ceding small parcels of land to individuals, the iqta' process turned large areas of land to Vizirs and other governmental officials who worked these areas as estates and plantations. There were taxes and revenues that were remitted to the

Caliph, but the use of these lands was left in the hand of those immediately managing them. Iqta' was a functional means of remotely controlling (and collecting taxes) from the vast areas of Egypt. As such, the state was capable of running Egypt with only marginal returns.

Grain exports continued to be of primary importance to the administrators of Egypt during the initial Muslim conquest period (639-868 A.D.). Grains were shipped north to the Umayyad governors of Damascus, and later to Baghdad, the capital of the Abbasid empire. There is little evidence that either the Umayads or Abbasids invested much in upkeep or construction of Fayoumi irrigation works.

The end of the Umayad period found the Fayoum to be an abandoned hinterland where the last of the deposed Umayad Caliph's, Marwan II was murdered by his own troops as he tried to flee to the safety of the Fayoum's frontier.

The Abbasids relocation of the Caliphate from Damascus to Baghdad diminished the importance of the Egyptian province. The economic and political instability of this period is shown in the rapid succession of the Umayyad and Abbasid caliphates.

> During the ninety years of the Umayyad caliphate, twenty-two governors ruled over Egypt; in the first ninety years of the 'Abbasid caliphate there were fifty-four, of whom no less than sixteen were in the ten years following the accession of al-Ma'mun--a sure sign of slackening authority. So far as can be judged from revenue figures available to us the same period saw an accelerating economic decline. (Lewis 1970:177)

The Abassid Caliph al-Ma'mun (813-833 A.D.) established the institution of qabala taxation. Qabala taxation initially meant that an individual was accountable for paying the taxes due from a given plot of land. This early form of tax-farming was transformed by various regimes, but its basic principles remained until the time of Muhammad Ali.

The political instability of the Abbasied period brought Byzantine raids to the coast, while the lack of concern with the problems of irrigation and agriculture brought the country "to the verge of collapse" (Lewis 1970:178). It was this failure of the distant caliphate to effectively manage Egypt that brought about the more regionalist administration of the Tulunid period.

Ibn Tulun became the administrator of Egypt (868-905) in a move to "prevent the emergence of political autonomies" (Lewis 1970:178). Ibn Tulun was allowed to administer Egypt autonomously from the Abbasid Caliph in Baghdad, the immediate result of this was an increase in cultivated lands, and a lowering of tax rates (Lewis 1970:183). The most significant hydraulic achievement of the Tulunids (868-905 A.D.) was the construction of the second Nilometer on the Island of Roda. There are no known records indicating changes in the Fayoum's irrigation scheme under the Tulunids, but the whole of Egypt did experience some improvement in agricultural production.

The brief Ikhshidid period (935-969 A.D.) was marked by a major earthquake, plague, a proliferation of invasions in the south by Nubians and (at its close) the Fatimids in the west. Little is known of the Ikhshid's attention to irrigation works, though Mas'udi records the elaborate celebrations and ceremonies associated with the cutting and closure of irrigation dams (see Lane-Pool 1969:85-86). Most of the (short) Ikhshidid period was managerially concerned with rehabilitating the recently damaged and neglected lands.

The Fatimid's (989-1171) proclaimed all lands to be the private property of the Caliph, taxed heavily and continued to leave Egyptian irrigation in a state of widespread disrepair. The Fatimids were so negligent of their irrigation infrastructure that the periodic low floods during their administration were particularly devastating. The "administrative, fiscal and economic breakdown culminated in a series of terrible famines" and evoked periodic anarchy throughout Egypt (Lewis 1970:188). A low Nile in 1025 devastated the cities and countryside, everywhere people became,

> sickened and died for want of food, and the stronger turned brigand and plundered the caravans, even of pilgrims; the roads were infested with robbers, and the Syrian rebels invaded the frontier towns. . . .The palace itself was so short of food, that when the banquet for the Feast of sacrifice was spread, the starving slaves swept the table. (Lane-Pool 1969:135)

Half a century later the el-Yazuri administration found itself in a similar situation and was forced to try to beg two million bushels of grain from Constantinople (Lane-Pool 1969:143).

The worst of the Fatamid famines was the "Seven Years Famine" (1066-1072 A.D.) which was so sever that "men were reduced to eating dogs and cats, and according to al-Maqrizi, even human flesh" (Lewis 1970:188). The Seven Years Famine was the result of power struggles between the Turkish, Nubian and Berber factions of the Fatimid army which destroyed central irrigation works throughout Lower Egypt. The Nubian troops,

> held all Upper Egypt, and 40,000 horsemen of the Lewata overran the delta, and abandoned dikes and canals to destruction, with the open intention of starving the inhabitants. . . .The fellahin, in terror of the armed bands that infested the land, dared not carry on their work, and the usual effects of a bad Nile were thus prolonged to successive years. (Lane-Poole 1969:146, emphasis added)

Salah ad-din (Saladin) founder the Ayyubid dynasty, returned the administration of Egypt to the Sunni caliph when his uncle (Shirkuh) installed him to replace the Fatimid vizier Shaawar.

The Ayyubids were less concerned with irrigation and agriculture than they were with defending the Levant and their frontier from the invading European Crusaders.

The Mamluks: General Administration

The evolution and structure of the Mamluk state has peculiar features unlike any other known evolutionary system. The term "Mamluk" means "owned". Mamluks were slaves, purchased as children, and subjected to a strict education regiment, and then emancipated at the completion of their education. This created a social structure with a unique balance of loyalties between the larger Mamluk state and those who had been their masters.

Al-Mahzumi's 12th century treatise on agricultural administration, taxation, planting and irrigation is an important source of information on medieval society in Egypt. His document is a blueprint of agri-management that details the chain of command and accountability used by administrators, and it provides the guidelines for understanding the roles of various individuals involved in Egyptian agricultural production.

The government of this age was a weak centralized state that dictated and monitored the execution of irrigation and agricultural tasks. The mamluks installed tax farms throughout the countryside called iltizamat. Tax farmers (multazim) collected and remitted the due tax, and were then rewarded with a land grant (usya land) "on which he paid the land tax (miri) only, and which was cultivated by corvee labor" (Marsot 1984:7). Two canons were compiled each year, one in the spring and one in the fall. In the fall, each piece of land was required to carry a canon "compiled by plot and basin in September, [that] was to estimate the number of irrigated feddans, and to determine the crops to which these feddans could be disposed in the new agricultural year" (Frantz-Murphy 1986:11). In the spring a second survey was taken and checked against the fall's measurements and calculations.

The Mamluks conducted land surveys and differentially taxed lands on the basis of whether they were actively or passively irrigated (Frantz-Murphy 1986:99). A Recorder and Surveyor were primarily responsible for the fields' areal assessment (Frantz-Murphy 1986:13). At each step of the process, numerous others verified the figures and calculations, these included: Accountant, Recorder, Measurer, Cultivators (Murphy-Frantz 1986:15). In September during the time of the Nile's flood the Recorder verified the area of land inundated by a given year's flood. But,

> aside from his recording responsibilities, the Recorder was also responsible for disposing the land, i.e., assigning specific crops to be grown on irrigated land. His agronomical tasks included playing some role in the distribution of the customary seed advance and being responsible for seeing to it that any flooded area which could be drained was. (Frantz-Murphy 1986:14)

Taxation was the immediate goal of this thick bureaucracy, and the profits of the taxation went directly into the establishment and maintenance of the strong-centralized state which exerted more and more control over production.

> The government also gave guarantors tax concessions for bringing undeveloped land under cultivation, for the greater the area of cultivation land the larger the tax base. Like the documents, the narrative sources too suggest an expansion of the cultivated area while also providing indirect evidence of an increase in population. (Frantz-Murphy 1984:136)

Many Mamluk officials were more concerned with establishing their own estates than with their official duties. Aybak al-Afram, the master of public works responsible for all irrigation works during the late 13th century had amassed a personal fortune so large that Ibn Taghirbirdi jested "he was so wealthy that he could have bought all of Egypt" (Irwin 1984:38). As we will see below in the reports of Nabulsi, the Fayoum's irrigation was in a desperate state during this period.

The sons of Mamluk sultans (known as sidi) farmed the choice lands throughout Egypt. From the fact that many sidi preferred to manage lands in the Fayoum, we can infer that at least some lands in the Fayoum were well kept in this period. In the 14th century, lands held by sidi in the Fayoum not only had far greater returns than other lands in the Fayoum held by non-sidi, but they also had greater returns than most lands outside of the Fayoum.[1]

> The average fief of a sidi in Fayyum was eight times more lucrative than the average fief of the province. In most provinces of Egypt the ration was only 2 to 1. In Gharbiyya, the largest province, it was almost exactly 3 (2.98) to 1. (Haarmann 1984:155)

The locations of these Fayoumi lands held by sidi are unknown, but given the state of the region's irrigation system and its history, it is difficult to imagine their location anywhere other than adjacent to the main canals in the central and eastern Fayoum.

Nabulsi

We are fortunate to have Nabulsi's first hand reports of Fayoumi irrigation during the 13th century. Abu 'Othiman al-Nabulsi was a Syrian-born civil servant in charge of overseeing irrigation and other state works during the mid 13th century. Little is known about Nabulsi other than what is provided in his writings, which record the extent of maintenance enacted by the Mamluks of his time.

The Mamluk administrators of Egypt have been described as being negligent in the maintenance of public works and the general good of the economy. Taxation of the farmers in the Fayoum was severe and scores of farmers abandoned lands at rates comparable to those during the Roman period (Shafei 1940:286). Lapidus writes that Mamluks actually

> foster[ed] the ruin of the countryside. Oppression forced peasants to flee the villages. Greed meant neglect of irrigation and investment in agricultural production. (Lapidus 1967:28)

The importance of Nabulsi's writings are seen when they are contrasted with the general managerial character of the Mamluk state. If these were truly times of minimal state maintenance, then they provide data on the minimal level of state maintenance under which the Fayoum has functioned in the post-state period.

> The village sheykhs were subordinate to the district governors, who in turn returned to the governor-in-chief; but the central government interfered little with the district officers, or these with the peasants (fellahin), so long as the taxes were paid; and the whole machinery of government was directed to the end of collecting as large a revenue as possible. A special department, however, had charge of the irrigation, and appointed inspectors annually to see the maintenance of the government dikes and dams; but the local dikes were left to the management of each separate village or town, and paid for out of the local funds. (Lane-Poole 1901:18)

Nabulsi distinguished between Fayoumi and Nile Valley irrigation systems on the basis of the Fayoum's reliance on saqiyas for the lifting of water to fields (see Ball 1939:220-221; Nabulsi 1958). Unfortunately it can not be determined from Nabulsi's writings which saqiya he was referring to. Both the animal driven wheel and the undershot waterwheel are called saqiya. Both forms of the saqiya were used in the Fayoum in the medieval period, though the widespread disrepair that Nabulsi found the Fayoum in would suggest that the animal driven wheels would be required because a poorly-maintained irrigation system could not produce the flow rates needed to drive undershot wheels throughout the region.

There was no usable drainage system for the Fayoum in the 13th century. Shafei in his review of Medieval Fayoumi geography notes that the tail-end (down-stream) of the Bahr Warden canal was in "ruins" due to neglect of basic irrigation maintenance (Shafei 1940b:296). Ball interprets a similar state of neglect.

> Owing to neglect of maintenance of the canal beyond Lahun, much water that would otherwise have been available for the irrigation of the Faiyum during the flood-season was lost by escaping through breaches to the north; and a further diminution in the supplies that could be utilized on the lands of the province resulted from the distributory canals becoming partially choked by silt and wind-borne sand. He ascribes the blame for this state of things to former governors; for on looking up the old registers of official expenditure in the province, he found that there was no record of anything having been spent on the maintenance of the canals during a period of more than 100 years. (Ball 1939:22)

Nabulsi was unaware of the long historical cycle of intensive canal repair followed by severe neglect and concluded that the state of neglect had occurred for the past 2600 years.[2] It seems likely that the repairs to the Fayoum's irrigation effected during Nabulsi's administration lasted only a few decades before the system again relapsed into disrepair (Salmon 1901a, 1901b & 1901c; Shafei 1940a). The records available to Nabulsi indicated that, one hundred years earlier water from Bahr Yusef flowed into the Fayoum eight months out of the year, but neglect had reached such a point during his stay that the Fayoum did not receive any water eight months out of the year (Nabulsi 1958:14). The dike systems throughout the central Fayoum had fallen into such a state of general disrepair that many of the most productive lands lay unfarmed (Nabulsi 1958:18). Nabulsi listed pages of the names and descriptions of villages which were abandoned due to the widespread collapse of irrigation maintenance. The distant villages of the central and western Fayoum were abandoned because maintenance conditions deteriorated to the point where even subsistence agriculture could not be supported.

In 1517, one year after defeating the Mamluks in the battle at Marj Dabiq (Syria), the Ottomans gained control over Egypt. At the battle's end, thousands of Mamluks defected to join the ranks of the new Ottoman leaders. Throughout the Ottoman period the ancestors of these Mamluks continued to hold most of the rights and powers held by their forefathers. A period of "local despotism" developed among these households of "neo-Mamluks" (Holt 1970:377; Hansen 1984).

Holt called the Ottoman administration of Egypt "a drift to anarchy" because most Ottoman administrators decentralized the management of agriculture and delegated regional authority to governors throughout the countryside (Holt 1970:374). The mamluk descendants governing the rural districts (sanjaqs) had been co-opted by the Ottoman state to cement their hold on the countryside, but the result was quite the opposite: they instead used collected revenues to strengthen their own households and weakened the central power of the Ottoman state. Struggles between the core and periphery resulted in revolts and uprisings throughout the Ottoman period (e.g 1586, 1604, 1609, 1711). Hydraulically and agriculturally, this continuance of Mamluk power meant that the established patterns of neglect in the Fayoum were to continue. There were periods in which irrigation repairs were undertaken but the Fayoum's lands were never reclaimed to levels approaching that of the Ptolemaic or Roman periods.

In the early 18th century the Ottoman state briefly wrestled power from the countryside and established a centralized Beylicate. The Beys directly collected taxes and controlled the administrative offices of the countryside. The "Great Insurrection" of 1711 ended this period of centralization and the control of the countryside fell to several Beys who independently governed various regions.

The last Ottoman ruler of Egypt, Ali Bey again centrally reorganized Egypt's agricultural administration, but upon his removal from power, this short "period of centralization came to an end as each bey scrambled for his share of the booty" (Marsot 1984:6). Agricultural decline followed Ali Bey's rule and the end of the Ottoman period,

> The anarchy, expressed in uprisings and revolts, was an expression of indigenous resistance to extortion, and meant not "chaos" but a loss of central control over the countryside. (Marsot 1984:15)

In 1784 there was a famine so severe that the fellaheen "ate everything that was thrown into the streets, and their hunger was so terrible that they ate the raw corpses of horses, donkeys and camels" (Marsot 1984:15). The next year a plague killed one sixth of the population and the early 1790s had a series of plagues and famines so severe that there were reports of cannibalism (Marsot 1984:15; al-

Jabarti Vol. 2:239 cf. Wainwright 1940). This was the state of Egypt when it was so easily "conquered" by Napoleon. The irrigation system was in such disarray when Napoleon's expedition arrived, that only about a quarter of the arable lands were being farmed.

Summary and Conclusions

The medieval period brought little change in the techniques and technologies of irrigation agriculture for the Fayoum and Egypt as a whole. If anything, the primary change of this period was a systematic increase in the neglect of irrigation upkeep. Canals were clogged, drains were at times nonexistent, and entire villages (of the Fayoum's "down-canal" interior) were abandoned.

It is with reticence that I characterize the medieval agriculture and irrigation systems of the Fayoum as vacillating between stagnation and decline. Characterizations of medieval European history as "stagnant" have created a misleading popular image of a European "dark age" by ignoring evolutionary advancements in architecture, farming techniques, maritism, navigation, metallurgy, mining, optics, to mention a few endeavors (see Singer et al. 1954). It would be similarly wrong to characterize the whole of medieval Egypt as a period of stagnation. Al-Azhar, the world's oldest university was established in Cairo in 970 A.D. Egypt experienced dramatic advancements in medicine, the arts, engineering, astronomy, architecture, warfare techniques and machineries, commerce, finance, literature, and long distance trade techniques. But in terms of irrigation techniques and agricultural production there were minimal improvements (as measured by increased production) during this era.

Private property holdings decreased while taxation increased during the Muslim period. Villages rather than the state became the focus of agricultural administration, the role and authority of the shaykhs replaced that of a centralized state. The iqta taxation system complimented decentralization by bolstering the authority of estates. With the various regions of Egypt responsible for the maintenance and construction of irrigation works there was a general lack of supra-local concern with hydraulic works, and the result of this in the Fayoum was a minimal agricultural return.

The Mamluk period records of Nabulsi give us our best view of the Fayoum during the Medieval period. The irrigation system had been so neglected that down-canal villages were abandoned and agricultural productivity occurred at minimal levels.

The "local despotism" of the Ottoman period did not effectively coordinate supra-regional maintenance of Egypt's Irrigation system. Localized administrators were concerned with the hydraulic works of other regions only to the extent which their disrepair interfered with their own agricultural endeavors. Ali Bey's increase in centralized agriculture and irrigation management produced exceptional agricultural returns. It was in the post-Ottoman period that centralized efforts to overhaul the hydraulic works of the whole of Egypt led to the successful rehabilitation of the Fayoum's neglected irrigation potential.

Notes

1. Fifteenth century records indicate that the Fayoum was still an important location for such sidi holdings.

2. Ball concludes that Nabulsi's estimation of 2600 years was a reference to Herodotus visit to the Fayoum (see Ball 1939:221).

CHAPTER 9
IRRIGATION AND THE FAYOUM: COLONIAL AND REVOLUTIONARY PERIOD

> The Egyptian Peasantry were ruining their land by overcropping and overwatering, not out of ignorance but out of a desperate indebtedness: they were forced to maximize their incomes every year, even at the expense of the future, in order to pay the moneylended. ---Judith Tucker

Egypt's European/colonial period began with the arrival of Napoleon Bonaparte's Expedition d'Egypte in 1798. Napoleon's stay was short, but his troop's impact was long felt. Muhammad Ali modeled his army's organization after that of Napoleon's (Tignor 1966:32).

Muhammad 'Ali gained control of Egypt in the first decade of the nineteenth century. His domination of northeastern Africa first introduced global capitalism to the Egyptian economy. It was his goal to use the capital gained through intensive agriculture to amass an army capable of wrestling regional power from Constantinople.

Some author's have argued that the economy of this period was feudal ('Amer 1958:120), on the basis that peasant's did control the tools and means of production, worked for subsistence and received little if any monetary pay. 'Amer portrays the system of iltizam tenure and taxation as a survival from the earlier days of the precapitalist Mamluk domination.

While there are many features of the economy that resemble feudalism, this view does not fully consider the importance of the world market economy in which the products of labor were sold. Nor does it appreciate the radical shift in labor value that occurred with the installation of perennial irrigation works throughout Egypt--as Alan Richards has shown, transforming labor costs (Richards 1982).

Under Muhammad 'Ali the Egyptian State despotically controlled agriculture. Laws were issued in 1812 which prohibited the Fellaheen from selling grain, and later (1816) other crops to anyone but the State for low prices, who then marketed these goods in the outside world (Tucker 1985:25). As if that were not enough of a load for the fellahin to carry, "they suffered the additional burden of buying back grain, at higher prices than they had sold it, for their own consumption" (Tucker 1985:26). Wittfogel viewed Muhammad 'Ali's administration of Egypt as extremely despotic.

> In 19th-century Egypt "the whole corviable population" worked in four huge shifts on Mehmed Ali's hydraulic installations. Each group labored on the canals for forty-five days until, after 180 days, the job was completed. From 1881 on, at a time of decay and disintegration, "the <u>whole</u> of the corvee fell on the poorest classes", the smaller number being compensated for by an increase in the labor-time to ninety days. In some regions the conscripts kept busy "for 180 days". (Wittfogel 1957:25-26, quotes are Wittfogel's citation of Willcocks 1889:274-275)

After the centuries of Egypt-wide neglect of irrigation infrastructure, Muhammed 'Ali's attentions transformed agriculture and even the social structure of the countryside (Chaichian 1988). Historian Judith Tucker correctly recognized how far-reaching these changes were, though her claim that this was historically unique ignores the strong centralized management by some the Dynastic, Ptolemaic, and Roman regimes.

> The role of the State in the transformation of the Egyptian countryside really commenced under Muhammad 'Ali. The peasant family unit gradually lost control over the organization of its production and consumption as the central government interfered directly in peasant life through a system of agricultural monopolies, corvee labor, military impressment, and confiscation of peasant land. (Tucker 1985:25)

Irrigation and Agriculture

New irrigation methods and technologies allowed for the establishment of perennial irrigation in areas of the Nile Valley. Barrages were built throughout Egypt so that water could be stored for later use and redirected to lands away from the Nile. Corvee labor was used to dig deeper feeder canals, and pumps were installed to move water to new agricultural lands. With these improvements to the hydraulic system the agricultural economy was redirected from subsistence crops to new, more profitable varieties which could be sold in world markets. With the new irrigation sources of water, cotton and sugar for export became the most important crops.

With this transformation of the irrigation and agricultural system came a new responsibility towards maintenance. The importance of the Egyptian State's vigilance over maintaining irrigation works can been shown in the breach in the al-lahun regulator which occurred (either in 1819 or 1820) that was so severe that,

> It took two years to build two masonry walls with counter-forts at the site of the breach which may be seen until now. It was 500 meters long and the hole scoured is 8 meters below land level, and is about a kilometer west of Hawaret el Maqtaa. (Shafei 1940:287)

The Egyptologist/treasure hunter Giovani Belzoni visited the Fayoum during this irregularly high flood and reported that the lake rose to levels over three meters higher than anyone living could remember, causing significant devastation (Belzoni 1822:151-153).

Land Tenure

Mohammed 'Ali put an end to the iltizam system of tax farming in Egypt and replaced it with a system more concerned with quick financial gains for the controlling state. The motivation for these reforms was the international market for cotton, sugar cane and other cash crops (Blaut 1989). Year round agricultural production exerted new labor demands on the fellaheen, these demands in turn created their own relations of production; namely the new division of tamaliyya and tarahil laborers.

Tamaliyya laborers were residents of the large estates, hired on a yearly basis and were often paid by both wages or shares of subsistence crops (Richards 1979:501). In practice a variety of means of payment were available to tamaliyya laborers ranging from agreements for the fellaheen simply to pay the due land tax (Richards 1979:501). _Tarahil_ laborers, on the other hand, were little more than migrant daily wage workers (Richards 1979:501). In the Fayoum, the _tamaliyya_ were responsible for providing the tools, seeds and all aspects of labor for the plots they worked, and thus often fell into states of irrecoverable debt resulting in the landlord retaining any monetary payment that would have otherwise been their due. Housing for laborers was provided (at a fee) in the form of mud huts on the estate grounds.

Residents of the _Sa'id_ (Upper Egypt) composed a large part of the migrant _tarahil_ labor force. This region's irrigation infrastructure was little changed by the developments of Mohammed 'Ali's rule. Sa'idees could work in their own region (most often as sharecroppers for landlords) in the months that the natural rise and fall of the Nile made agriculture possible. After the harvest was gathered, many sa'idee would travel north in search of work as _tarahil_ on the perennial estates of Lower Egypt. Naturally the landowners in the Fayoum capitalized on the resulting surplus of labor by reducing wages.

The _tarahil_ were generally paid at a higher rate than the _tamaliyya._ Richards makes the point that this differential was a sort of "unemployment insurance premium".

For the bulk of the year they would be unemployed (1979:502). Tarahil workers also required more supervision than the tammaliyya, as they did not have the vested interest in the crops that a share cropper did.

After Muhammad 'Ali's death the governance of Egypt was taken on by his sons Ibrahim Pasha (for one year in 1848), Sa'id (1854-1863) and grandsons Abbas Pasha (1848-1854) and Ismail (1863-1879). Abbas Pasha discontinued most of the modernization policies of his grandfather, after the murder of his uncle Sa'id (1854-1863). Sa'id reinstated his father's program of modernization and singlehandedly created a foreign debt of more than eleven million pounds.

The American Civil War's disruption of international cotton markets was a boost to cotton growers in Egypt. At the onset of the war, the United State supplied Europe with over eighty percent of its cotton. European markets first reacted to cotton shortages by pushing new fashion lines of thin muslins, but it was not long before the shortages turned to collapse (Landes 1958:69). England turned to Egypt and India to make up the balance, India was capable of out producing Egypt, but it was of a weak, short fibre and its general filth was unacceptable to British expectations (Landes 1958:71).

Ismail (son of Ibrahim Pasha) took on the Turko-Persian title of Khedive in 1863. Ismail continued the westernization programs of his grandfather, though he was at least as concerned with adopting the "high culture" of the Europeans (i.e. the establishment of a National Opera, Library, Geographical Society etc.) than he was with improving the countries agricultural system. Isa'il did continue with Muhammad 'Ali's plan to transform Egypt to a system of perennial irrigation (Tignor 1966:38-39). Though the foreign income from cotton sales declined after the American civil war, Ismail continued the policies of high expenditures.

When the pressures of unmanageable foreign debt began to be felt by Isma'il, he reacted by trying to squeeze more profits out of the already overtaxed peasants. He increased the land tax to 1/2 trying to cover his growing debts to England and other European countries (Brown 1990a:42). He even tried introducing an "advanced tax" on grain in a desperate attempt to increase funds. There were rebellions against these measures which prompted Isma'il to take further measures against the peasants. These included the introduction of civil law, a national police force, institutionalized village guards, the installation of a telephone and telegraph system that could increase the contact of the police with the centralized state (Brown 1990a:42).

The opening of the Suez Canal in 1869 increased European concerns with Egyptian management and when in 1875 Ismail could not make the interest payments on the foreign debt he was pressured into selling off Egypt's shares in the Suez canal to his European creditors. The following year British and French bankers pressured Ismail into establishing the Caisse de la Dette Publique and in 1878 the "Egyptian Ministry" governing Egypt's financial policies was formed, with Europeans appointed to important ministerial positions. Ismail was exiled in 1879 and his son Tawfiq was installed as the new Khedive by the European debtors. This increasing degree of foreign control led to the failed Arabi Revolt of 1882, and the strong British military response to this crisis brought the total British control over Egypt.

The Ibrahimia Canal (which brings waters from the Nile to the Fayoum via the Bahr Yusef) was designed by the administration of Bahgat Pacha and constructed by corvee labor in 1867-1869 (Ball 1939:225; Azia 1987). After this development, water left the Nile at Asyut instead of at Dairut. It was during this period (1868) that the Bahr Yusef Head Regulator at Al-Lahun was built at the entrance of the Fayoum (Aziz, F. 1987:59).[1]

Khedivial irrigation maintenance and improvements projects were performed by the fellaheen, with the aid of only simple tools; the fass (iron hoe) and couffin (woven palm basket) (see Barois 1887:65). The labors of corvee were demanded by the state and enforced by,

> a severe use of the lash, and even with these barbarous methods it is almost impossible to have the earth carried as far as the top of the dikes; it is deposited merely at the foot of the embankment or along the slope

> a little above the level of low water--a true labor of Sisyphus, because each year the same earth slides to the bottom of the bed in high water. . . .(Barois 1887:65-66)

Article V of the Decree of 25 January 1881 "Regulating the Works on the Nile and its Canals" specified whom the state drafted for corvee (see Willcocks 1899:401-405).

> Article V. The corvee ransom is due from all male inhabitants of the country of sound health, between the ages of fifteen years and fifty years. . . .(Willcocks 1899:402)

While Article VII spelled out the terms of ransom by which a man

could free himself from the duties of corvee.

> Article VII. The cash payment of the ransom in the cases in which it is allowed is fixed in 1881 at 120 (one hundred and twenty) piasters per man in the provinces of Lower Egypt, and at 80 (eighty) piasters in those of Upper Egypt. (Willcocks 1899:403)

The end result of this clause was that the duties of maintenance and construction fell upon the poorest Egyptians, specifically only those owning less than five feddans were bound by corvee (Willcocks & Craig 1899:405). For example in the district of Kafr Sheik in 1885, those owning less than twenty percent of the land performed all the corvee duties (Willcocks & Craig 1899:405).

> Legally, the fellaheen ought to have supplied 438 men for 90 days: they were called on to supply 1091 men for 180 days, and actually supplied 800 men for 180 days. (Willcocks & Craig 1899:405)

Legislative attempts to include more of the populous in the duties of corvee (such as the Decree of 1885) failed to engage the corvee labors of the large absentee proprietors or their tenants (cf. Barois 1887:68-69; Willcocks & Craig 1899:413; Boinet 1892; Moncrieffe 1886).

When the British gained control over Egypt's management there were vast stretches of silted canals; packed silt where once there had been adequate drainage and tracts of land uncultivable due to salinization. The Fayoum was in a state of near collapse (Tignor 1989; Tollefson 1990). In the Fayoum, Lake Qarun had even risen enough to reclaim what had previously been productive farm land (Tignor 1963:64).

> After the bridge of Ellaoun [al-lahun regulator], the Bahr Youssef continues as far as the chief place of the province [Medinet-el-Fayoum] whence start all the canals which water the province, forming divergent ways along which are arranged the special outlets and whose surplus flows into Lake Keroun.
>
> In consequence of the abundance of irrigation water, the level of the lake has been raised some 4 meters in latter years, thus overflowing land heretofore cultivable; also the lack of drainage canals in the low parts has tended to render salt and sterile quite a quantity of land. (Barois 1887:43)

Barois noted that the irrigation repairs in the Fayoum were exceptionally expensive in the late 19th century, costing an average of "3 francs per hectare" (Barois 1887:43).

The basic methods of water lifting in the Fayoum were still gravity, the saqqiya, and the undershot waterwheel. The undershot waterwheel in the late 19th century Fayoum lifted the water in ceramic buckets and were estimated to be "sufficient to irrigate for summer crops an area of 13 cultivated hectares" (Barois 1887:79).

The British reworked the ravines and levies at the entrance to the Fayoum in order to control the waters of exceptionally high floods (such as that recorded by Belzoni earlier in the century).

> To keep the level of water for irrigation, however, two of these deep ravines were banked across by massive earthen dams, while at the third an old escape-head was built up. By turning the Bahr Yusef over the limestone bars it was kept on the watershed and rendered capable of feeding all the canals of the province. The maintenance of all these embankments in first-class order is a matter of the greatest importance. A breach would be attended with the most disastrous consequences. (Willcocks 1897 cited in Ball 1939:232)

Debts, Irrigation and Cotton

Britain's previous experience with irrigation works had been in India. Though the nature of irrigation in these two environments was quite different, some of the engineering applications could be transferred from India to Egypt by many of the same engineers who--as noted earlier by Marx--had allowed the Indian irrigation system to decay into an abysmal state of mismanagement. The Egyptian Ministry of Public Works was primarily formed from a pool of these engineers.

Sir Colin Scott-Moncrieff was placed in charge of Egypt's Irrigation Service. He ran the Service by recruiting British engineers from India. William Willcocks, a graduate of Thomas Civil Engineering College of Rorkee who had been born in and lived his entire life in India came to Egypt in 1883 to work under Scott-Moncrieff. Willcocks spent three years surveying the Nile basin in order to find a location for what was to become the first Aswan Dam (Smith 1975:51). H.R. Brown, the sub-head of the department of irrigation, traveled extensively in the Fayoum and designed numerous improvements to the system of irrigation water delivery. But Brown's interest in Egyptian agricultural production was more than charitable. Judith Tucker records a letter from Lord Cromer's private secretary to his mother in 1900 in which it is observed that Major Brown "made L400,000 by rigging the market with information he had", while Lord Cromer himself is reported to have made "a colossal fortune" (from Tucker 1985:36).

At the time of Scott-Moncrieff's arrival the level of Lake Qarun had risen due to "faulty drainage, thereby submerging large amounts of otherwise arable land" (Tignor 1966:114). The Ibrahimiyah Canal (which ultimately supplied water to the Fayoum),

> . . .was improperly looked after. Because of its faulty alignment and silting in the canal bed, it carried only a fraction of the water it should have. (Tignor 1966:114)

It was the state, more than the peasants, which was to benefit from the "prosperity" of perennial irrigation. Higher yields were soon transformed into higher taxes and the bulk of cash crop profits were retained by the state[2].

> The abolition of corvee did not even give peasants greater independence. Since its abolition was linked with the replacement of basin and flood irrigation by

> perennial irrigation, the end of the corvee was also linked with increased government control over water. (N. Brown 1990:75, emphasis added)

Of course the "prosperity" of perennial irrigation also had its maintenance corollaries, in one sense it meant "there were more canals to dig and clean than ever before" (Tignor 1966:121 cf. Blunt 1967).

In the first decade of British foreign rule, there was an increase in arable land in the Fayoum (Tignor 1963:72; Atkinson 1934). The British began the conversion of Fayoumi lands from basin irrigation to canal irrigation. At the end of the nineteenth century, the Fayoum accounted for just under 50% of Upper Egypt's perennial irrigated land (260,00/521,000 acres) (Willcocks & Craig 1899:136/pp 142).

> In Lower Egypt and in the Ibrahimia Canal tracts summer irrigation is fully developed, and half the lands are under summer irrigation, while in the Fayum development is still very backward and considerably under one-third is under summer crops. (Willcocks & Craig 1899:142-143)

While Willcocks noted that the Fayoum provided poor agricultural returns, he also recognized that the Fayoum could be exceptionally prosperous with the attention of the State Ministry of Irrigation.

> The Fayum, however if skillfully handled, and no province needs more skillful handling has a great future before it. (Willcocks & Craig 1899:151, emphasis added)

Willcocks also recognized that up-canal Fayoumi irrigators had agricultural advantages over their down-canal neighbors.

> In the Fayum to-day it may be stated generally that all the low lands are sacrificed to the high lands. The rich high-lying plateaus traversed by the heads of the

> canals and their upper reaches, with plentiful water assured to them all the year round, with the valuable manure deposits of the ancient mounds, and with perfect drainage,are the delight of tourists, and typical of perennial irrigation at its best. But of the rest of the province it may be stated without fear of contradiction that if the canals were doubled in section and rendered capable of carrying early and plentiful supplies of flood water, and if this water were utilized in irrigating the summer crops on the high plateaus, rice and maize on the secondary plateaus, and providing basin irrigation to the depressions and valleys, the province would be far richer than what it is to-day. (Willcocks & Craig 1899:161, emphasis added)

The British rescue of Egyptian irrigation was only short lived and Willcocks did not get to see the Fayoum irrigation system rehabilitated as he had envisioned. Had the Fayoum's canals been properly maintained, the grotesque differences between irrigators at the head and tail of the system would have been reduced. By 1900 the British focus on increasing irrigable water supply was damaging fields because adequate drainage techniques had not been developed (Tignor 1963).

The British did attempt to standardize the Fayoumi irrigation system and agricultural production methods, though there is ample evidence that the new rules were more frequently broken than obeyed. As Barois had noted, large landholders freely used their positions to acquire disproportionate shares of irrigation water:

> The farmer enjoys the greatest of liberty in opening the ditches or making inlets in the banks of the canals, and in abusing the water which flows across his land. No rules exist for regulating the discharge; no ration is established between the surface cultivated and the dimensions of the works of inlets. Under

> these conditions the large proprietors have evidently great facility for monopolizing the water for their own profit to the detriment of the small farmer. (Barois 1889:100, emphasis added)

Much of the financial restructuring of Egypt was borne on the backs of the Fellaheen. The British allowed the Fellah to borrow seeds and money against future returns from (sharecropped) cash crops at high interest rates. The increase of fellahin debts under British rule lead to whatever private land holdings ('Ushri) were left being taken over by large landowning companies (al-Disuqi 1976).[3] The fellahin were being pressed to the limits of tolerance, but their options of opposition were minimal.

Nathan Brown interprets the behavior of the fellaheen during the colonial period as being explicitly political, rather than the fellaheen simply being helpless victims.[4] Brown demonstrates hundreds of incidents throughout Egypt in which peasants took (illegal) actions against the state and landed class during the nineteenth and first half of the twentieth centuries. Brown reasons that many crimes during this period were actually "political" in nature. The Fayoum was a region with an active resistance to state control during this period:

> In December 1922 the owner of a five-hundred-acre estate in Fayyum province was shot dead along with her accountant. Although the murder occurred in front of the residents in broad daylight they all claimed ignorance of the identity of the criminal. It was finally ascertained that the owner of the weapon used in this double murder was a former resident of the estate who had been evicted by the owner. (N. Brown 1990:104)

Caton-Thompson documents methods used by Fayoumi farmers to illegally evade the taxation of the Egyptian state during the 1920's.

> The low ground near the modern desert-border at the east end of the lake [Qarun] is cultivated to the present day after the winter rains on a small scale by law-evading natives, whose meager material return from them is doubtless handsomely enriched by the fun of eluding the vigilance of the tax-collector. (Caton-Thompson & Gardner 1934:96)

With time, the cost/benefit ratio for the British presence in Egypt declined to the point that the British withdrew entirely from the management of Egypt. The British withdrawal should be understood in terms of the larger decline of the British Empire. Historian Patrick O'Brien has demonstrated that the global shifts in costs and benefits of British colonialist enterprises brought about the end of its global power (O'Brien 1988; Wallerstein 1979).

The Officers' Revolution

Land Tenure: Dreams and Realities

The agrarian reform movement was the most far reaching aspect of the 1952 officers revolt and the revolution that followed. Though much of the land redistribution was later undone by the Sadat administration, the general restructuring of land ownership among the poorest farmers is still in place.

This first measure of agrarian reform came only a few weeks after the revolution, its (purported) purpose was to curtail the holdings of the 0.1% of landholders who controlled over 20% of the land, and to redistribute the gleanings of this excess among the masses.[5] Nasser wrote that the intent of these laws was to overthrow the pattern of "tyrannical feudalism" in the name of egalitarianism (Nasser 1959:50). But the end result was not so much an egalitarian redistribution as a shuffling and re-dealing of land titles (Hussein 1973).

The Agrarian Reform laws have undergone numerous changes since their initial implementation. The September 9, 1952 law's main provisions: limited land ownership to 200 feddans and redistributed this land in plots ranging from two and a half to five feddans; Restricted the further division of land (through inheritance or sale); Formed agricultural cooperatives with mandatory memberships for landowners; Established a fixed contractual rate of rent for farm lands at seven times the allowable land tax (Ansari 1986; Saad 1988).

Richard Adams in his book Development and Social Change in Rural Egypt, demonstrates that the actual effects and goals of Nasser's land reform movements were a means of disarming the old guard rather than being motivated by egalitarian motivations. He concludes that,

> Land reform in Egypt was designed as a political strategy of elite replacement that was intended to eliminate the rural aristocracy allied with the ancien regime. It was not designed as an economic mechanism for qualitatively transforming the basic factors of Egyptian agricultural production. (Adams 1986:87)

Ansari further points out that,

> The truth was that the first agrarian reform law was quite moderate, involving no more than 8.4 percent of the cultivated land. Roughly only 365,000 faddans were available for redistribution among 146,500 families in small parcels ranging from between three and five. faddans (Ansari 1986:79)

One group of elites simply replaced another. The overall structure of the arrangement changed little, especially when considering the peasant population. Less than ten percent of the peasant population gained any land through the land reform programs--though this figure has drastically varying results in different districts (Adams 1986:87; Cuno 1984 & 1985; Deeb 1984; al-Dessouki 1984).

The Socialist Laws of 1961 cut the allowable limit of land ownership in half to only 100 feddans (Saad 1988:4-5). On December 20, 1970 Sadat signed into law a measure calling for the return of land reappropriated under the previous land reform laws (Ansari 1986:159). Among the reasons given for rescinding the earlier policies was the claim that small plots of land prevented the implementation of modern mechanized farming methods, but clearly the real reason was that the large-landholding families of the past still exerted power in the new post-revolutionary government (Ansari 1986).

The Fayoum had plenty of large landholding families. Ansari calculates that at the time of the first agrarian reform laws, the Fayoum had one of the highest proportions of "families with multiple, large landowners in the upper [in terms of size] group" (1986:124). The same pattern of highly concentrated land ownership in the Fayoum was also found with the expropriations accompanying the 1961 reforms.

It was during the 1960s that the post-revolutionary State began requiring its farmers to first plant nitrogen depleting cotton in their fields. Egypt was receiving more than $1.2 billion dollars in aid per year from the Eastern Bloc and as a result was "forced to pay part of her external debt in kind by mortgaging its cotton crops" (Ansari 1986:177).

> Egypt which purchased abroad 7 percent of its food stuffs in 1961, saw its imports increase to one-fifth of national requirements a decade later. Though as late as 1974 the country maintained a favorable net agricultural balance, by 1981-82, shipments of agricultural products from all foreign sources accounted for one-half of the total domestic food consumption. (Ansari 1986:189)

Revolutionary Fayoum Irrigation

The irrigation system Nasser and his administrators inherited was in fairly good shape, though the canals throughout the country did suffer from a lack of maintenance during the confusion of the regime's first years of power. Informants living in the central Fayoum during Nasser's first years recounted that this period had a general deterioration in water delivery due to a total lack of coordination by the new Ministry of Irrigation. The Fayoum's irrigators experienced some hard years during the new government's transition.

> The upkeep of the main irrigation canals and drainage ditches in the expropriated estates was also the sole responsibility of the Agrarian Reform staff during the transitional period. . . .(Saab 1967:74)

Work gangs were organized, but the results were "not impressive, many beneficiaries and tenants were always absent, and the upkeep of drains and canals was extremely poor" (Saab 1967:75). In the end the upkeep of canals during the early years was left up to the farmers who these canals served (Abdu al Hakem 1954). The poor maintenance lead to poor drainage conditions which in turn resulted in low values for the redistributed land reform properties in the Fayoum (Saab 1967:120; Allan 1983).

The revolutionary government was more concerned with land redistribution than with the underlying irrigation system. Post-revolutionary administrations rebuilt weir and regulator systems within the Fayoum and dug a number of canal and drainage systems, but left the overall gravity-fed layout of the system unchanged (Ayrout 1952). The Aswan Dam allowed the Nile and Delta regions to engage in perennial irrigation for the first time, but the dam's effects (as compared to the rest of Egypt) on the Fayoum were minimal. The Aswan Dam has helped regulate the year-round flow of water available to the Fayoum, but compared to the dam's perennial impact on the whole of Egypt it's impact on the Fayoum has been minimal.

Summary and Conclusions

The technological changes in Egypt's irrigation from Muhhamed 'Ali's administration to the present have increased agricultural productivity in the Fayoum, but only through an increased state presence in irrigation management. These hydraulic changes were engineered and coordinated by centralized regimes, though the labors were performed by the fellaheen--who, previous to the Officers Revolution, received few benefits from their labors. Worster concludes that,

> Following a. . .logic of discontent, Egypt in the nineteenth century converted to a perennial irrigation system that required expensive storage reservoirs, more canals and headgates to regulate the passage of water, artificial fertilizers to replace sediment trapped in the reservoirs, and considerable disruption of rural life. In its favor, the new system made possible several crops a year, including cotton for exporting to the world markets. So Egypt abandoned its time-tested ways and became rich--or at least some of its citizens did. It shipped its products abroad until it no longer raised enough food to feed itself. And step by step it came to confront a mounting ecological backlash: salinity poisoning, degraded fisheries, and higher levels of schistosomiasis than ever before. (Worster 1985:43)

The self-maintaining estates and waqf estates of the medieval period were not erased by Mohammed 'Ali, they were transformed and more efficiently co-opted by total state control, to a degree greater than had previously developed. All of this came as an after effect of the radical irrigation technology introduced by Mohammed 'Ali that effectively doubled agricultural output for all of Egypt.

Despite his Albanian roots, Muhammad 'Ali was a classic Egyptian despot. He recognized that the desperate agricultural condition of Egypt at the beginning of his rule could be overcome through a strong centralist reworking and control over the entire country's irrigation. His centralized state again transformed the barren lands along the Nile and in the Fayoum, though in humanitarian terms these transformations occurred at a high price.

The Officers' Revolution brought to power a new top-heavy bureaucratic regime. The Nasserist pseudo-socialist Egyptian state expanded the state's bureaucracy throughout the countryside. The Ministries of Irrigation and Agriculture quickly became vital controlling links between the state and villagers. Various hydraulic projects throughout Egypt gave post-revolutionary governments unprecedented control over the flow of the Nile and its adjoining canals.

The last four thousand years of the Fayoum's history demonstrates the direct correlation between centrally managed irrigation works and agricultural productivity. Though various technological innovations (saqqiya, undershot wheels, dikes, barrages) have altered the specific nature of Fayoumi irrigation, the basic responsibilities and coordinating efforts of the state have remained paramount.

Administrators from the Dynastic to the Colonial period have had to learn the hard way that state neglect in the Fayoum meant agricultural collapse. Unfortunately, the anciently cultivated but now barren lands at the Fayoum's desert edge testify that this is a lesson not learned by more modern administrators.

We will see in the next chapters that due to the Aswan High Dam and the availability of cheap portable pumps, much of contemporary Egypt's irrigation agriculture is accomplished with minimal state management. But in the contemporary Fayoum this is not the case. In the Fayoum a high level of state management is still required for agriculture to function at even minimal levels of productivity.

Notes

1. The Bahr Yusef Head Regulator retained a head of 2.95 meters of water (Aziz, F. 1987:59).

2. Timothy Mitchell's post-modern critique of European colonial forces in Egypt, insists that western motivation for their activities in Egypt was little more than a compulsion to recreate the other in their own image. For example, in the 1880's a number of schools were built throughout Egypt (including the Fayoum), all using the same blueprint designs. For Mitchell, the entire project is nothing more than a "common attempt to construct order, which has come into being as an end in itself" (1988:78).

> Colonizing Egypt, in the broad sense of the penetration of a new principle of order and technique of power, was never merely a question of introducing a new physical discipline or a new material order...The world was something to be constructed and ordered according to an equivalent distinction between physical "things" and their non-material structure. (Mitchell 1988:126-127)

For Mitchell, the operationalization of the existence of a "peasantry" is only an "invention" by occidental forces bent on dehumanizing those they exploit and hold back from the luxuries of development (Mitchell 1991). This argument leads a radical particularist approach in which the rejection of the term peasant is nothing less that the rejection of the possibility of cross-cultural research.

Motivation for exploitation is transformed from a realm of economic gain at the expense of others, to that of a society driven by a compulsive need for order. The atrocities of colonialism are in some ways reduced to the whims of an anal Victorian culture.

Mitchell never bothers to ask (much less answer) the question; what is it that the British wanted to do with this "order" they were installing? In the Fayoum, the answer is clear and simple enough: to increase production, while minimizing the frictions of resistance inherent in such an undertaking.

3. In 1879 the British fix tax rates at 28.64% of rental value of land and it was not until 1939 that the rate was lowered to 16% (N. Brown 1990:52).

4. Brown sees the peasant's actions as aimed toward a single political end:

> Peasants were not anarchists; their aim was not to destroy or defeat the state but merely to cope with the state, to stave it off, to make it less relevant (N.J. Brown 1990:216).

5. This estimate of the 0.1% of 1952 landholdings come from R. Adams 1986:87). Prior to 1952 land reform law 5% of people owned 65% of the land, while after the first land reform law came into effect 5% still owned 54% of the land; The 1961 Land reform law curtailed this to 6% owning 48% of the land; In Egypt today 5% of the people still own 50% of the arable land (see figures in Central Agency for Public Mobilisation [sic] and Statistics 1989:64-67).

PART TWO

IRRIGATION MANAGEMENT IN THE CONTEMPORARY FAYOUM

CHAPTER 10
CONTEMPORARY IRRIGATION IN THE FAYOUM: THE STATE

> Nowhere do the ecological anthropologists--nor does Wittfogel, for that matter--seem to realize that the link between water control and social power might occur in places other than the archaic cradles of civilization nor that the past hundred years have seen more irrigation development than all of previous history. --Donald Worster

This chapter examines the influences of state administration efforts on Fayoumi irrigation in the present day, as well as reviews the current conditions of modern Egypt. A general view of the Egyptian state's role in Fayoum irrigation is undertaken before discussing on-the-ground, local irrigation in the following chapters.

The State Milieu

Life in the Fayoum occurs in the milieu of the larger Egyptian state. Before examining the structure and function of Fayoumi irrigation organization, some background on the Egyptian state as a whole must first be discussed. The influence of the state is formidable, it controls the prices of a variety of items ranging from basic food stuffs, gasoline, public transportation to seeds, fertilizers and other agricultural necessities.

Most of Egypt's land is uninhabitable desert. Except for the few sparse oases of the Western and Eastern Deserts, only the thin northern coast line, the Delta, and the few miles on either side of the Nile make up the habitable land of Egypt. The minute dimensions of <u>habitable</u> Egypt are staggering, the cultivable Egyptian Nile Valley is only an area 3 to 8 kilometers wide in most places and a distance of a thousand kilometers long, the Delta has a potentially cultivable area of over 20,000 square kilometers. In all, less than 4 per cent of Egypt is habitable.[1] In terms of habitable land, Egypt has one of the highest population densities of any country on Earth: 1,400 persons per square kilometer.[2] Bangladesh only has a raw density of 625 persons per square kilometer and a habitable density of over 900 persons per square kilometer.

Egypt has experienced tremendous population growth during this century. Just over one hundred years ago (1882) Egypt had an estimated population of 7,930,000 people, today the most reliable population estimates are around 60 million people.[3] Egyptian agriculture is nothing if not labor intensive. The technologies employed in irrigation and agriculture are for the most part rudimentary but effective. The rates of population growth are the result of labor intensive farming practices. Population growth throughout the rural-agrarian countryside did not increase labor demands though it created a number of unanticipated side effects (al Khule 1982).

Rapid population growth in this century has had the unanticipated effect of severely fragmenting privately held land. In just the two generations that have passed since the 1952 Officers Revolution--and the land reform acts that followed--there has been a steady process of devolution of landholdings. It seems that the smaller the land holding the greater proportional sub-division and disintegration. Large families owning more than 50 feddans have almost half as many children as fellaheen with less than 3 feddans. This is primarily due to the different labor demands dictated by different productive strategies (i.e. small farms use families for all aspects of labor while large farms hire nonfamilial labor) (see Ansari 1986; Abdel-Fadel 1975; Arab Republic of Egypt 1989).

The level of population growth and overcrowding has reached the point where Egypt can no longer grow enough food to feed itself. The granary of the ancient world must now import food stuffs at levels equivalent to Egypt's food needs for four months out of the year. Over fifty five billion dollars in foreign debt has accumulated in the last few decades, though Egypt's (somewhat reluctant) involvement in the Gulf War earned it debt forgiveness on over 30 billion dollars (Cunningham 1990).[4] The level of debt must be understood in terms of Egypt being a country where the <u>average</u> per person level of income is estimated to be around $750 U.S., though I would estimate the average income of many of the Fayoum's fellaheen to be closer to about 450$ a year. Put in terms of possible individual earning and buying power this puts the Egyptian debt at a level far more severe than the United States National Debt or that of any developing nation. There are numerous reasons for the debt but much of it can be tied directly to the Camp David Peace Accords of the late 1970's where President Sadat's government was faced with collapse or internal revolution and saw the promised foreign aid benefits of the Peace Accords as a solution to immediate problems rather than a mortgage of future independence that they became.

Government Organization of Irrigation in the Fayoum

Today, the Egyptian state manages three vital aspects of irrigation in the Fayoum. The state governs the very supply of irrigation water; the construction and maintenance of irrigation "infrastructure"; and the establishment and ultimate enforcement of irrigation rules and laws. The state supplies irrigation water by coordinating the nationwide network of dams, barrages, canals and weirs. The Ministry of Irrigation must coordinate hundreds of up-river kilometers of water flow in order for the Fayoum to receive adequate quantities of irrigation water. The State's supervision of the Ibrahimia Canal and Nile's up-stream waterways is necessary if the Fayoum is to receive sufficient agriculture to support current population levels. The Ministry of Irrigation coordinates these up-river activities in ways a locally administered irrigation system could not.

As with any bureaucratic undertaking there are local, regional, and national figures directly and indirectly influencing the actions of local individuals. The backbone of the Fayoum's regulatory system is managed by local officials (discussed in the next chapter) who, for the most part, only call in the force of the state when their own persuasion is lacking. But the power of the state is always present, and this knowledge is enough to diminish some degree of obvious theft and rule breaking.

In the larger scheme of things, the Egyptian government is responsible for the nature and regulation of the Nile's flow, and in turn the flow of the Bahr Yusef branch that ends in the Fayoum. Twentieth century bureaucrats manipulate sluice gates and canal networks to distribute irrigation water just as the Pharaohs tried to coerce the deities responsible for the fall and rise of the Nile. Beyond the chore of simply providing water, the State also regulates its specific distribution.

The Egyptian government would never claim to enact any laws opposed to the teachings of Islam. But compared to other Middle Eastern countries the irrigation laws in the Fayoum have next to nothing to do with Islamic water and irrigation laws (e.g. Yemen, Saudi Arabia, Sudan etc. see Caponera 1973). Though the Fayoum's irrigation rules do not violate the Islamic principals of equity and access, the principles of water distribution are based entirely on secular rather than religious doctrines. When I asked Muslim fundamentalist farmers if they wanted Islamic law to govern even the irrigation system the answers were always strong affirmatives. But when further asked what this would actually entail there was no consensus, nor was there any demonstrated awareness of how Islamic law is applied to irrigation elsewhere in the Arab World (see Wilkinson 1978). These farmers only answered that irrigation laws based on Islamic teachings would lead to greater equity and higher agricultural returns for all.

Modern changes in Egypt's overall hydraulic capacity have changed the Fayoum's relative contribution to Egypt's agricultural economy. Whereas in the past the Fayoum was the singular region capable of year round irrigation agriculture, today perennial agriculture is the national norm (Development & Technological Planning Research Centre 1980). In fact, today the Fayoum has productivity levels actually below that of the rest of the country.

> The agriculture of the Fayoum Governorate. . .is essentially the same as that of the Delta and the Nile Valley, but with one major difference: the irrigation is not by lift but by continuous gravity flow. Although the range of crops grown is the same, the cropping pattern in the Governorate is different from that of the Delta in that the 'nili' crop acreages are higher. The <u>agricultural productivity of the Governorate farms is reputed to be much lower than for the rest of Egypt</u>. (Agrar 1982:1)

The intensive double and triple cropping practices of farmers along the Delta and Nile valley overshadow the Fayoum's current agricultural productivity. The contemporary Fayoum is a region whose strength lies in its consistency, and its (overall) agricultural independence from water lifting technologies--though it pays for this in greater managerial upkeep costs. The Fayoum not only has a different productivity rate, but it also has different water-lifting costs and a different social organization of irrigation.

The uniform reliance on pumps in the Delta and Nile Valley has led to the development of irrigation groups built around this specific technology (al Kady 1979; Knop et al. 1982). But, in the Fayoum, pumps are not universally necessary for irrigation. These differences in water delivery techniques and devices have impacted the social and economic formations of the Fayoum. As is discussed in the following chapters, these different delivery methods creates different structures of power and control for individual irrigators. The economic and energetic savings of not needing to lift irrigation water have economic and social costs for farmers far from water sources. The geographical formation of the Fayoum necessarily requires some level of supra-regional organization beyond that of the Nile Valley to keep canal ways open and water flowing.

Water From Aswan to the Fayoum: Gravity-Fed Irrigation, How the Fayoum is Different

Throughout Egypt, the state's Ministry of Irrigation operates thousands of hydraulic works, the largest and most important is the High Dam at Aswan. The Aswan Dam allows the storage of and diversion of water for a number of down-river uses, including diverting water (via the Ibrahimia and Yusef Canals) to the Fayoum. Aswan's High Dam serves a number of functions in Egypt's economy. Primarily it was designed to regulate the flow of the Nile and secondarily to generate electricity. It has accomplished both of these goals to some degree--though its electricity output has always been overestimated and it does not even generate enough electricity for either the extant villages or industry[5] (Waterbury 1979:147). The High Dam makes perennial irrigation possible throughout Egypt by storing and regulating the excess summer water flow for use in the winter. The dam has also allowed perennial irrigation and cropping throughout Egypt, though this benefit has had the costs of increased waterlogged soils and the loss of the Nile's fertile silts.

The Ibrahimia canal leaves the Nile near the Assiout Barrage about three hundred kilometers south of the Fayoum. The Ibrahimia Canal serves hundreds of farms along the

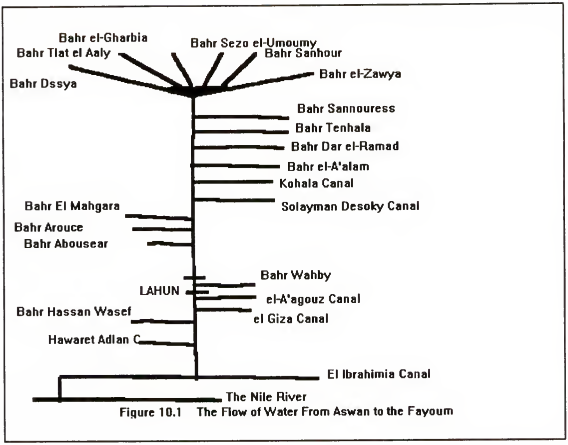

FIGURE 10-1 Schematic of Water Flow from Aswan to the Fayoum.

western Nile Valley as it flows towards the Fayoum. All canal water enters the Fayoum at the Bahr Yusef regulator near the village of al-Lahun in the eastern Fayoum. The Bahr Yusef Head Regulator was reconditioned between 1960 and 1962 and given a new capacity. It has a bed width of 54 meters; an average depth of 7 meters.; in cross section it is 413 sq meters; average water velocity is 82 meters/ min. (1.37 meters/sec), for a total quantity of 27,092 sq meters per day. (Aziz, F. 1987:59). The regulator at al-Lahun constantly controls the quantity of water entering the depression. Beyond this point, there are eighteen major irrigation canals down which the water can travel before reaching feeder canals and fields (el-Quosy et al. 1981:13-a). Regulators at each of these canals further control the amount of water distributed through the Fayoum.

The Bahr Yusef canal carries water into the Fayoum until it reaches the city of Fayoum (Medina al-Fayoum) near the depression's center where "it ends in a broad delta with the water distributed to a fan like pattern of blind ended distributary canals which never reach Lake Quaroun" (el-Quosy et al 1981:13). Various Islamic Hadiths attribute the construction of Bahr Yusef canal, to Joseph of the Quran and Old Testament. Sir Hanbury Brown recorded a folktale at the turn of the last century which suggested that Joseph reclaimed the lands of the Fayoum as a test of his competence, and that the region's name was miraculously derived from the Arabic "alf youm" (thousand days) required for its reclamation.[6]

Water Management Technologies in the Fayoum

The most significant difference in hydraulic technology between the Nile, Delta and the Fayoum is the later's reliance on weirs (nasbah) for the ultimate measurement and distribution of water (see fig 11-1).[7] The state allocates the Fayoum's irrigation water with the assistance of hundreds of these weirs.

> Because of the special circumstances in Fayoum[--]that is having terraces sloping moderately towards the

> Quaron Lake[--]water distribution is controlled by a system of clear overfall weirs in order to keep the water slopes in the main canals relevant to the land levels on both sides. (el Quosy & Guindi 1981:13)

This has created a situation where--with proper maintenance--an automatic distribution of water can be assured throughout the entire system at relatively low technological costs. Nasbah are found wherever Fayoum canals drop in elevation (in the absence of undershot wheels), or where a canal splits to other canals or enters distribution canals leading to fields.

> The level of the weir sills is the same throughout, but the width of the waterway, or length of weir crest, in each case is made proportional to the area of land served by the branch. Provided that the weirs all have a free fall. . .the distribution of water is practically fair. (Brown 1907:199)

The weirs used today were originally designed and installed by British hydrologist a century ago but their general use remains the same. In the Fayoum, the size and shape of sluice-gates allows for the calculation and distribution of predetermined quantities of irrigation water (Brown 1892; el-Quosy & Guindi 1981; Brown 1905 & 1908).

Weirs (nasbah) are located at the intersections of both small and large canals throughout the system.[8] The Fayoum's weirs have precisely measured flow openings which regulate the quantity of water that pass through them. The gates on the weirs are set at widths proportionate to the cumulative size of the field groups their water is to serve. The wider the lip and notch, the greater the flow of water that is permitted past it. The entire system is controlled by the al-Lahun regulator at the Eastern entrance to the depression. Water that is unneeded in the Fayoum is diverted outside of al-Lahun to the northern flowing Giza Canal. Up-canal regulation of water is effected by gates at Assyut and the Aswan High Dam. The al-Lahun regulator (and its predecessors in the same general location) is a technological continuation of ancient techniques that also controlled the incoming flow of water.

The combined conditions of inclined landforms and available waters allow for the use of four different types of weirs in the Fayoum. The four types of weirs used in the Fayoum are as follows:

> 1- Tadil (model) 24 i.e. [Head] = 24cm in which every 1 mm of width serves an area of 1/2 feddan.
> 2- Tadil 36 i.e. [Head] = 36 cm. in which every 1 mm of width serves an area of 1.0 feddan.
> 3- Tadil 54 i.e. [Head] = 54 cm. in which every 1 mm of width serves an area of 2.0 feddans.
> 4- Tadil 69 i.e. [Head] = 69 cm. in which every 1 mm of width serves an area of 3.0 feddans. (el Quosy et al. 1981:14)

The actual flow rates of a given canal location determine the width of a weir. Given an adequate water flow, a weir's width regulates the quantity of water which passes down canal. The Ministry of Irrigation regulates a stable amount of flow past their gates by only allowing the predetermined amounts of water to pass through their crest. The weir networks are the technological backbone of the Fayoum's irrigation.

Though the physical mechanics of the Fayoum's weirs are simple (there are minimal moving part), they are an efficient technological means of water allocation, so long as their canals are well maintained. If the canals throughout the network fall into disrepair the calculated integrity of the entire system is vulnerable. The Ministry of Irrigation is acutely aware of this predicament in the Fayoum and accordingly it monitors the region's irrigation at levels higher than elsewhere in Egypt.

Across the Fayoum, as the landscape's elevation declines from east to west there are reductions in the costs of water lifting and delivery to fields. These reductions in water lifting costs are for the most part unknowingly experienced by the fellaheen spread throughout the Fayoum. These changes in water delivery costs, and differing levels of irrigation security have resulted in different cropping patterns and farming strategies throughout the depression. Changes in farm lands' elevation result in the formation of subtle micro-environments which in turn effect aggregate changes in the capabilities of farm lands.

All lands in the Fayoum are not agriculturally equal. There exists something akin to a natural-potential productive value of a given plot of land. This determines the labor needed to reach a given level of productivity. This is a value which can not be considered separate from the available technological productive means available, as well as the available cultigens. The different labor requirements of land plots will (over time) have both economic and social effects on the communities that farm them.

The mineral content of soils, access to water and drainage, temperature and available sunlight all contribute to a land's agricultural value. There are regions in the Fayoum which are better suited for specific crops over others. This is a result of both changes in landforms and the specific locations of plots relative to limited, vital commodities--such as water, or soil located at suitable elevations.

The lands of the central Fayoum depression have a high natural agricultural value because of the ease with which they can receive water year round. In years of water shortage this is an advantage of immeasurable worth. The lands of the central and western Fayoum also have accumulated greater amounts of alluvial deposits than the lands to the east and thus have richer soils. It is this central region that produces the most lucrative cash crops such as orchards and vineyards. In any given region, a plot of land's physical relationship to water and other plots will determine its relative productivity.

For the whole of the Fayoum, those lands adjacent to source canals have an edge over those at a greater distance. The edge is slight but, given that the difference between a marginal and bumper year can be determined by slight amounts of water, the edge is enough to be important. With the introduction of private property, these differences can be translated into monopolistic holdings. There is a natural advantage to be claimed by irrigators whose plots of land are nearest to water sources. This advantage may be one that is seldom used, but when conditions of scarcity arise, this Liebigian[9] advantage is enough to determine the success or failure of a crop. After all, it is not the average success of a farmer's efforts for in Egypt, "mean years are of no value since the surplus of one year is not available for the next" (Sir William Willcocks cited in Waterbury 1979:87).

Mehanna et al. incorrectly concludes that time (not water) is the limiting feature of Fayoumi irrigation. They write:

> Time, the number of minutes in a week, is the constraining factor in Faiyum. Farmers have little choice but to organize themselves to allocate it[,] have little choice but to organize themselves to allocate it [sic] fairly and rationally. They cannot break the time barrier with pumps as do the Delta saqia ring groups. (1984:92-93 emphasis added)

The fallacy of this argument can be easily shown by asking what would be the result of allotting an endless supply of time to this system (keeping the amount of water constant)? While one half of the answer would be an increase in agricultural production, the more significant long term answer would be: severe water shortages (and arguably. .

.increased salinization). Citing time as the limiting feature ignores the current near disastrous situation of water shortages. On the other hand adding more water to the system would lead to the evolution and adoption of new water allocation methods.

Mehanna et al.'s insistence that time is the limiting feature of Fayoumi irrigation is an effect of their theoretical orientation toward structural (as opposed to infrastructural) explanations. What they are calling "time" is simply the structural division of water: the true limited resource. If Mehanna et al. could increase time they would first have to increase the water supply feeding their infrastructurally determined schedule. Irrigators in the Delta saqiya rings do not have more time, they instead have a greater access to water (through pump technology).

Terracing

The state is able to deliver the Fayoum's irrigation water without the use of pumps or other lifting technology because of the region's natural terrain (see figure 10-2). This natural terrain has been accentuated with a combined exploitation of canals and terraces.

Terracing in the Fayoum is subtle. There are no grand hillsides with carved and scaffolded land-plots. The

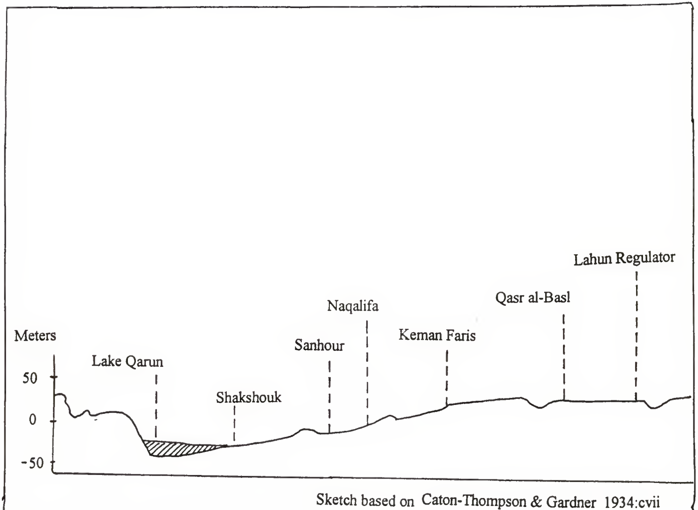

Figure 10-2. North-south profile of the Fayoum Depression.

Fayoum's situation is similar to William Mitchell's description of the similarly subtle terraces of Peru's Ayacucho Valley which are "unrecognized as such even by their users" (1985:289). In the Fayoum the terracing is often barely noticeable, one plot of land often has an elevation only a few centimeters different from surrounding plots. In other areas, plots of land are raised a quarter to half meter or so above adjacent fields, while others are separated by terraces of over three meters. As Fayoum landforms change from east to west there is an increase in artificial terracing. The primary exception to this rule are the steeply terraced lands that immediately surround the most eastern drainage canals of Wadi Wadi and Wadi Bats. Terracing occurs in this region as an attempt to use the deep drainage ravines along the Wadi's banks.

The trend of increased terracing in the western Fayoum occurs to better extend the capacities of delivering irrigation water by harnessing the gradual slope of the natural landscape. Terracing allows an extended use of water by establishing diminishing levels of land elevations away from water sources. Terracing is a technological adaptation which increases and stabilizes available lands while optimizing water delivery systems by controlling the elevation of a given plot of land. In other regions of the world, terracing functions to create farm land on otherwise unusable hill sides (Spencer & Hale 1961). In the Fayoum, terracing is instead a technological response designed to extend the delivery range of the traditional gravity-fed irrigation system.[10]

Some terracing is the result of the practice known as "scooping out", in which top soils are strip mined for the manufacture of both fired and sun dried bricks. Mud bricks are still manufactured in the Fayoum as they are throughout East Africa. Small plots of land adjoining hut, houses, fields or courtyards are cluttered with wooden brick-making forms. Bricks are made in batches and left to dry, and are then stacked along the sides of huts.[11]

Most of the terracing in the Fayoum is not simply due to "scooping out." It is clearly done to maximize water and land use as the environment and elevation subtly changes from east to west (Spencer & Hale 1961). If water can be kept flowing at a minimal level below or at field levels then little if any lifting of water is necessary. In some cases in the Fayoum, water even drops as a waterfall to fields below its flowing level (as is the case to the northeast of Naqalifa). In the central Fayoum there are remnants of an ancient (most probably Roman) aqueduct, modified and still in use which transverses topographic irregularities and drains.[12]

The Ministry of Irrigation

A variety of institutions govern irrigation related activities. These activities range from the allocation of irrigation water to the supervision of the construction and maintenance of water works. Egypt's Minister of Irrigation has the widest sphere of power and responsibility. As with any Ministerial position, the person occupying such a position is both all powerful and powerless. All powerful in the sense that proclamations are as good as law, and powerless by the fact that laws and policies without enforcement or implementation are next to worthless.

The Fayoum has a "Director General of Irrigation" (answerable directly to the Under-Secretary of Irrigation in the Fayoum) who is responsible for the irrigation activities throughout the provence. His staff includes two "Inspectors of Irrigation." Each of these Inspectors have four engineers to assist him. Each Markaz has engineers responsible for the flow of irrigation water. Additionally there are hundreds of technician spread throughout the Fayoum who carry out the tasks of canal maintenance: administrators, records keepers, gate operators and gate inspectors. The responsibility of these men is to keep the water flowing until it can be delivered to the villages.

> Each inspector [and their staff] is responsible for an area of about 175,000 feddan and is assisted by four senior to junior engineers. . . .The irrigation engineer has his headquarters at the "Marqaz", the district's main town, and is helped in his duties by some technical staff ("gate operators") and administrative staff (accountants, storemen, administrative officers etc.). . . .the [Ministry of Irrigation] operates and maintains the system up to a mesqah head only; thereafter, each mesqah and the area it serves are managed by a "mesqah organization" which appoints a responsible [mesqah headman] for its day-to-

> day management. Deficiencies are reported by the "mesqah headman" to the District Irrigation Engineer. (F.A.D.P. 1982, Annex 1:11)

In the Fayoum, the Ministry of Irrigation even has its own police force which investigates charges of water theft and other irrigation incidents. Mehanna et al. noted that this was an enforcement entity particular to the Fayoum region.

> Faiyum has a unique feature among Egyptian Governorates: [ibid] it has an Irrigation Police Unit. . . .When official reports are received by the Security Authority about an infraction, a police officer accompanies the Irrigation Engineer to investigate. The former writes the legal part of the report, and the latter its technical part. The irrigation police has also ten inspection post throughout the governorate, where policemen guard particularly sensitive points on canals from being altered. Finally the irrigation police collect fines from people who have committed infractions. But the Irrigation Police have no power to arrest people. This is part of the ordinary police functions. (Mehanna et al. 1984:129-130 emphasis added)

No Egyptian irrigation official I spoke with had an explanation for why the Fayoum was the only Governorate needing a special Irrigation Police Unit, but given the Fayoum's special reliance on gravity-fed irrigation, the reasons are clear enough: A seemingly minor irrigation infraction can easily deprive an extensive chain of down-canal irrigators, threatening the entire balance of the Fayoum's system. Much of the central and western Fayoum farm lands are also served with the aid of the animal driven saquiyya (noreia) and undershot waterwheels, and are thus only secondarily gravity-fed fields. The centrally controlled irrigation of the Fayoum necessitates a higher degree of compliance with irrigation laws than do governorates along the Nile and the Delta.[13]

Once irrigation water has passed through its last distribution weir, the primary responsibilities of the state are over. The lifting and individual allocation of water becomes a local concern. The fact that the state's primary responsibility ends with the last weir reveals an important dynamic between the Fayoumi fellaheen and the state. Beyond this point allocation assumes a more local character--though the state still backs the authority of this structure. In some since this arrangement cloaks the state's influence on local irrigation issues. Most analysts have focused on the organization and power of local munawaba irrigation groups (discussed in the following chapter) and ignored the larger effect of this structure on the state's hydraulic investment. The state's hydraulic investment/ management strategy is concerned with the net crop taxation produced, not with the success and failures of individual farmers.

Consider--from the state's perspective--the costs and benefits of the state's self-imposed responsibility for water until the last weir: The state removes itself from the most minuscule and tedious of bureaucratic duties by imposing the duties of day to day allocation on local groups. The state evades (in its perspective) the most trivial arguments and squabbles, and only intervenes in local disputes when the general peace and local order is threatened.

I would argue even that (functionally) the state couldn't care less about fellaheen steeling water from each other, the state is only really concerned with the theft of state water. This is because the state still receives the same level of net due taxation, whether or not there is an individual increase in one individuals crop production due to his theft of a neighbor's water. The state receives the same net tax whether it is from a thief or a law-abiding citizen.

The state's concern with irrigation related crimes is quite a different matter when it concerns theft of water before it reaches the last weir or the alteration of irrigation infrastructure. Theft and sabotage at this level creates more work for the state. When weirs are damaged by fellaheen wishing to increase the local water flow, the quantity of water allocated for other canals can be drastically altered. A single such act at a key canal requires the state to take some action, to do otherwise would risk disorder if the flow is significantly altered. The Fayoum's Irrigation Police will at times intervene in local disputes, but they are primarily concerned with violations occurring along the main waterways.

Drainage

The responsibilities of irrigation drainage fall on both the Ministry of Irrigation and the fellaheen. The Ministry of Irrigation supervises the maintenance and construction of the Fayoum's large drainage canals and the fellaheen maintain the drainage ditches carrying water from their fields to these main drains.

There are two types of drains in the Fayoum. There are private drainage ditches which carry used water to large secondary service drains. Though drains require less upkeep than irrigation canals, the state is responsible for the upkeep and management of the secondary service drains, while individual farmers served by drainage ditches are responsible for their upkeep.

Most plots of land in the Fayoum adjoin small drainage ditches which eventually carry the used water away to major drainage canals. For most farmers, the disposal of irrigation water is accomplished by simply opening an area in the dike surrounding their field and letting the water flow down to the drainage canal.

Salinization in the Fayoum has become such a problem that there is a growing recognition by both farmers and state bureaucrats that the state must invest in better public drains. Because the Fayoum's drainage system is so crucial to the long-term success of irrigation, the Ministry of Irrigation has paid special attention to drainage problems there. Since 1960, the state has been slowly attempting to replace the open drain canals with subsurface cement and PVC drainage pipes (F.A.D.P. 1982:9).

> Compared to other regions, the District [Fayoum] is well advanced in subsurface drainage. . . .The Ministry of Irrigation has the responsibility for construction and maintenance of drainage works. The anticipated remodelling of the main drains has already been included in the World Bank Drainage Project. Maintenance of public drains is financed out of the ministerial budget, and each of those drains is cleared once in two years according to a routine program prepared by the Ministry. The private drains are the responsibility of the landowners, but the Ministry has the legal right to interfere and undertake cleaning work if the good working conditions of the drains are not maintained. (F.A.D.P. 1982:9-10)

Farmers do re-use drainage water as irrigation water at times, and the Ministry of Irrigation is experimenting with the re-use of irrigation water by mixing it with fresh canal water. The suitability of drainage water changes with the seasons, the winter months produce the least saline drainage water due to the seasonal reduction in evapotransporation rates (el-Quousy 1981:35-37). The mixing of drainage water with fresh water for irrigation requires careful monitoring to assure acceptable levels of salinity, as the Fayoum is faced with continued water shortages, this re-use of water will require a greater state supervision.

In the long-run, drainage of irrigation water is as important as acquiring the water in the first place (Casey 1972). If water is left to sit on land there is a great danger it would destroy the soil by waterlogging it and increasing its salinity. All lands in the Fayoum must have access to some form of drainage outlets or the processes of evaporation and transpiration will ruin the soil.

Egypt is in danger of destroying vast areas of irrigated lands through the neglect of drainage. The need for improved drainage is in part a result of the decline in yearly silt deposits since the construction of the Aswan High Dam (Waterbury 1979:129-135). In the past when the Nile rose in yearly floods, salinization (due to standing water) was also a problem, though the nutrient rich silts lessened the severity of this problem. Current levels of over irrigation and waterlogging have raised the water table in all habitable areas of Egypt.[14] In many areas of the Fayoum, the water table has risen as high as the root zone which leads to salinization of these soils (especially in areas near lake Qarun). Added to this problem are increasing levels of Nile salinity (of at least 10 to 15 %) due to the High Dam.[15]

The villages close to Lake Qarun's shore sit in a precarious balance between the levels of salinization and the level of the lake. When the rates of water flowing into Lake Qarun exceed the rate of evaporation a paradoxical situation is created:

> This is a delicate balance because if the volume of drainage water exceeds evaporation, the water level of the lake will rise and may flood the cultivated and

> inhabited area. On the other hand if the opposite occurs, the salinity of water will increase. (el-Quosy et al. 1981:15-16)

If Lake Qarun's water increases in salinity, it does so at the cost of the fishing and shrimping industry that supports many of the villagers living along the lake shore (el-Quosy & el-Guindi 1981:15-16; Boraey 1980; Bishai & Kirollus 1980). The present situation is such that,

> Now the salinity of the Lake is increasing to a value which in the near future will exceed the tolerance value of artificially introduced salt-tolerant fishes. (Boraey 1980:102)

Boraey even suggests that varieties of salt-tolerant fish should be introduced from the highly saline Red Sea in order to keep fishing industries in the Fayoum afloat (1980:102).

One attempt to solve this drainage problem is the use of Wadi Ryan as a supplemental drainage basin. Wadi Ryan is a natural depression located 10 kilometers to the Southwest of the Fayoum basin. Drainage water is transported to Wadi Ryan via canals and a massive (state built) tunnel through the hills west to the Fayoum.

The Ministry of Agriculture

Throughout Egypt the Ministry of Agriculture controls the very crops which the fellaheen are allowed to grow. This control is achieved by controlling access to seeds, fertilizers, pesticides and the establishment of crop quotas. As noted by the FADP, the hydraulic conditions of the Fayoum also limit the sorts of crops which can be grown there.

> Though the farmers [in the Fayoum] have a freedom of choice in determining their farm enterprises, in fact this freedom is fairly limited. First of all they are part of an irrigation-community which restricts the individual freedom of choice. Then there are climatic factors influencing the community's cropping choices. Additionally there is the 'quota' system which by several means (legislative, credit facilities) allows the Government to influence the cropping pattern. (F.A.D.P 1982:10)

Fellaheen come in contact with the Ministry of Agriculture at various point during the yearly agricultural cycle, but most commonly this contact occurs when they approach the agricultural cooperatives which issue seeds, fertilizers and pesticides for the state. The government tracks the crops farmers grow by requiring them to get approval from the government cooperative before they are loaned the seeds and fertilizers they need. Farmers then must go to the government controlled Village Bank to get a loan of seed and fertilizer (for the historical roots of this system see al-Rafii 1914). This form of credit is another means used by the state to insure the extraction of profits and to control the Fayoum's fellaheen. The state does subsidize the costs of seeds, pesticides and fertilizers, but farmers are locked into payback agreements with the state when crops are harvested. At harvest time the government purchases quota crops from farmers at mandated prices.

> The so-called quota crops for which Government enforces areal [sic] quotas on farmers have to be fully or partly sold through Village Banks to governmental companies. Cotton, for example , is exclusively sold to Village Banks, whereas for crops like rice, sesame, onions etc. a certain tonnage per feddan has to be sold by the farmer to Village Banks/governmental companies. Price for quota crops are centrally fixed by Government and are substantially lower than comparable world market prices. (F.A.D.P. 1982:15)

Other crops, such as the highly profitable orchard varieties can be (somewhat) freely sold on the open market (usually in Cairo), thus providing farmers who can break into orchard crop production access to monetary returns that others can not achieve.

The state's required "quota crops" leave farmers with little choice but to at times violate the laws binding them to these quotas. Farmers have clear economic incentives to violate these laws. Abdou, Gardern and Green studied the violation of crop mandates elsewhere in Egypt and found these violations most common among farmers with relatively small landholdings (Abdou et al. 1986 & 1983).[16]

Financially, cotton and wheat are the most important quota crops for the state. Cotton is by far the most profitable export crop grown in Egypt. For thirty years the Egyptian government has been the only legal cotton purchasing agent, and it has consistently kept its price well below world market rates. Hopkins observed that,

> the government tries to maximize the gap between the purchase price and the resale price on the world market; this is intended to be a major way in

> which rural surplus is extracted for the benefit of the government's modernization and industrialization plans. (Hopkins 1987:145)

Cotton's central role in extracting the rural surplus through out Egypt has led to the Ministry of Agriculture's demand that all farmers plant cotton every two to four years, failure to do so means fines beginning at L.E. 175. But the rewards for the state carry severe risks for the fellaheen. Because of cotton's well known nitrogen depleting qualities, it is a dangerous crop to plant so frequently. Though, in the long-term, the risk of over cropping cotton is a risk for the state, in the short-term it is the fellaheen who are most at risk. Many fellah recognize that the repeated planting of cotton depletes nutrients (primarily nitrogen) from the soil and limits their agricultural freedom. Saad accurately notes the state's ability to manipulate fellaheen labor by controlling cotton production,

> Cotton is the most important crop for the state and the most burdensome crop for the peasant. It requires a lot of labour for its cultivation and is neither used by the peasants, nor does it have a profitable market outside. Perhaps it could be argued that the peasants view it as an overall tax, especially because all taxes and production expenses for it and coop expenses are deducted from the cotton price and what is left is usually very little, if any; for often the beneficiary comes out indebted after deducting all that is due to him from the cotton. Beneficiaries often say: "We pay everything from the cotton." (Saad 1988:64)

It is in this way that the state binds the fellaheen in servitude through cotton production. Mandating cotton crops is but one of the ways that the state "taxes" the fellaheen through indirect means. Though there are agricultural laws allowing governmental bodies to determine the planting distributions of a wide variety of crops, cotton is the crop which most often brings about any measure of enforcement.

Gafaf: Modern Corvee

Each year, the state mandates that fellaheen donate labor for the construction and maintenance of irrigation canals. Once a year, during the month of January, the Fayoum's water supply from Bahr Yusef is shut off for 18 days so that maintenance and construction work can be carried out.[17] This period is known as al-gafaf (gafaf in Arabic means "the drying up"). Gafaf occurs as part of a larger maintenance effort throughout all of Egypt and is functionally the modern extension of past administrations' institutionalized systems of corvee. Again, the geographical peculiarities of the Fayoum require a high level of canal maintenance for the system to function at present levels. If the Fayoum's main feeder canals are not kept clean, the necessary water levels will not be met and the system of distributory weirs will not function properly.

Water is held back at the Aswan Dam, and at main access canals (see Waterbury 1979). This helps recharge reservoir levels and allows maintenance work on down-river irrigation works. Closing some of the Dam's gates in mid-winter allows extra water to accumulate in Lake Nasser. Winter is a strategic time for this because the relatively low temperatures provide low evaporation levels and winter flows are always the lowest Nile levels.

In the Fayoum a variety of projects are undertaken during al-gafaf, some requiring heavy machinery and large labor pools, other activities are more individual in nature.[18] Large diesel cranes are used to scoop mud and clear out vast spreads of water hyacinths (eichornia crassipes) and other plants from major canals. Bulldozers and tractors are used to move and haul away piles of dirt moved to canal edges where it is later collected and taken away as topsoil for surrounding agricultural fields. In one instance I recorded canal soils being taken over 20 kilometers away to be used on lands that were being reclaimed from the desert near Qasr al-Basl. In this instance the soil was in effect purchased from the state by the farmer who was acquiring the soil.

Labor for gafaf activities is nationally requisitioned and locally administered and organized. Farmers also individually repair canals and other irrigation features directly used by them on their own initiative, it is the common irrigation works that require non-local directives for maintenance and construction.

Each munawaba group is responsible for providing a labor pool for gafaf activities. Primarily this is related to cleaning and construction activities in the immediate area of the particular munawaba group, though the Ministry of Irrigation can (and does) require groups to supply labor for larger projects outside the irrigators immediate area.

Gafaf activities are either related to maintenance or construction. Maintenance activities are predominantly concerned with the dredging of both large and small canals and waterways or the removal of plants from canals. The removal of hyacinths and other plants is most often accomplished by wading in the muddy canals and dragging the plants to the canal bank where they are collected and left to dry out. At the intersection of major canals large diesel crane-scoops are used to remove plants. The intersections of major canal branches can accumulate massive amounts of plants. At al-Lahun an area stretching back over 100 meters of hyacinths and other floating plants accumulated to the east of the al-lahun regulator. It was cleaned with the combined efforts of large machinery and a locally drafted labor force. There are also repairs to actual water lifting devices (such as *saqqiya* and the undershot waterwheel) and the repairing of waterway banks.

Gafaf Construction activities include the digging and reenforcement of canals, canal banks and lining irrigation canals. Around the city of Fayoum and Ibschaway, the Ministry of Irrigation directed several canal lining projects. These involved the draining of the Bahr Yusef, Bahr Tanhala and Bahr Sinnuris canals and then laying rebar and plywood forms and pouring concrete bulwarks. Workers are "recruited" for these activities by the Ministry of Irrigation through the localized munawaba groups.

Labor pools of farmers chop at the bottoms and banks of empty canals with hand hoes and then dispose of this dirt with goofas by forming a "bucket-brigade" and passing the dirt to the edge of the canal. Some of these efforts are quite large, for example along the Bahr Yusef Canal in the center of Medinet al-Fayoum over 400 men worked along a section of the canal less than 1/2 kilometer in length for most of the gafaf period. These men scooped tons of accumulated canal mud and formed extensive bucket-brigades to ferry this soil up to large trucks along the canal banks. In Medinet al-Fayoum there were also three large projects designed to line main canals branching off of Bahr Yusef.

In the five village irrigation communities discussed in the following chapter, I found that all irrigation households without exception contributed labor to the duties of gafaf. Some farmers worked on the maintenance of local irrigation works, while others worked under the direction of the state on projects located elsewhere in their district.

Summary and Conclusions

As compared to the rest of Egypt, the Fayoum's unusual reliance on gravity fed irrigation requires different technologies and higher levels of maintenance of irrigation works. Because pumps are relatively infrequently used in the Fayoum, gates and canals must be maintained or water will not reach the fields. In the Nile and Delta regions, water gateways and canals have been allowed to deteriorate without a significant reduction of water due to the reliance on pumps for water delivery.[19]

It is the Fayoum's reliance on gravity-fed irrigation which necessitate the state's high level of irrigation coordination. The importance of the state's role in enforcing Fayoum irrigation rules is best seen the existence of the region's special irrigation police unit. Though the Ministry of Irrigation is present throughout Egypt, the Fayoum's requirement for well maintained weir networks has led to the elevation of its central importance in this region. As will be discussed below, the state has a reduced presence in the other regions of Egypt where a wholesale reliance on pumps has taken the place of rigorous irrigation maintenance.

In some ways, <u>gafaf</u> is a modern institutional carry-over of the past practices of corvee. While the extreme punitive requirements for rendering service to the state have been dropped, the functional duties of farmers throughout the countryside are maintained. The overall compliance with <u>gafaf</u> requirements in the Fayoum illustrates the state's role in coordinating the irrigation of the Fayoum countryside.

In the next chapters we examine the administration and organization of irrigation at the local/village level, as well as the limits of the Egyptian state's ability to govern the daily lives of Fayoumi fellaheen.

Notes

1. Recently Timothy Mitchell has published a discourse criticizing such representations of Egyptian demographics (Mitchell 1991). Mitchell maintains that to frame discussions of Egypt in such an ecological setting is misleading.

> The description that invariably begins studies of Egypt's economic development constructs its object in two respects. In the first place, the topographic image of the river, the desert surrounding it, and the population jammed within it banks defines the object to be analyzed in terms of the tangible limits of nature, physical space and human reproduction... In the second place, the naturalness of the topographic image sets up the object of development as just that--an object out there, not a part of the study but external to it. (Mitchell 1991:19)

Mitchell cannot understand the usefulness of comparing the habitable population density of Egypt with countries such as Bangladesh or indonesia instead of Belgium or South Korea (1991:19). Part of Mitchell's quarrel with such demographic representations is that it does not adequately take into account the ratio of productive land per individual, thus Egypt's ability to double and triple crop is not automatically clear in such representations. This is a valuable point on Mitchell's part, though his second complaint is not so poignant. Here he argues that portraying problems as (what I will call) infrastructurally based, limits effective solutions to infrastructural solutions, not "social and political" (1991:19).

> Once the problems Egypt faces are defined as "natural" rather than political, questions of social inequality and powerlessness disappear into the background. The analysis can then focus instead on how to overcome these "natural" limits of geography and demography. (Mitchell 1991:23)

Mitchell's complaint that we should reject infrastructurally determined analysis because this leave us feeling helpless, and only offers possible technological solutions is illogical.

2. This figure is derived by dividing the Inhabited area of Km2 (excluding the barren area of Kism Ataka) 42,787 by an assumed population of 60 million--a figure that is no doubt low (area of habitable land from Central Agency for Public Mobilization and Statistics 1989:13).

3. As Waterbury (1979:36) notes the rates of per capita cultivated area for this last century have fallen from .60 (1992) to .15 (1975) [1991 rates estimated at .08], even with the increased rates of double and triple cropping and high yield crops Egypt's ability to even feed itself has fallen.

4. When Iraq invaded Kuwait in August 1990, Egypt owed over 60 billion dollars in foreign debts. Within months, the United States and other members of the IMF forgave over 30 billion dollars of this debt as a means of assuring Egyptian troops would be sent to participate in the western coalition's military force. The end result of this action is not yet clear, but there are signs that President Mubarak is now seen at home as more of a western puppet than he was prior to the war. Within days of the ground war there were riots at the University of Cairo and Ein Shams University in which students were gassed and some shot to death by Ministry of Interior riot police.

5. There are a variety of plans to build new electricity generating plants to support projected future industrial growth. These proposals range from the small and practical--such as wind generators--to the large and insane--such as more desert located nuclear power plants or the now defunct Qattara Depression Project. The last project would have entailed tunneling over 75 kilometers from the Qattara Depression (over 50 meters below sea level) to the Mediterranean Sea. Turbines would have then been located at the depression and water flowing into the area would the be used to generate power. The most outrageous aspect of this proposal involved using the power of "a controlled nuclear explosion" to tunnel through the rock from the depression to the sea (see Waterbury 1979:150).

6. Holt further notes that such stories tying the Fayoum with a historical Jewish figure such as Joseph "is perhaps due to the presence there of an ancient Jewish settlement, of which documentary evidence exists as early as the 3rd century B.C. (Holt 1953).

7. <u>Nasbah</u> is an arabic word meaning division or proportion.

8. All canal weirs in the Fayoum have their discharge calculated from the equation:

Q = 2/3 Cd B / 2 g H 3/2

where

Cd is the coefficient of discharge

B is weir breadth (width)

H is the head of water above the weir's crest.

The basics of this equation is determined by Bernuli's principle which states that: a given volume of a fluid can pass through a constriction only by acceleration since water is incompressible (equation from el-Quosy & el-Gunidi 1981:13).

9. Liebig's Law of the Minimum states that in terms of survival and growth, the most crucial factor is the minimum availability of any necessary component rather than the abundance of any one factor.

10. Some of the terraces in the central Fayoum seem to be quite ancient. I was able to draw some soil profiles of a cut terrace face near the village of Naqalifah. There was evidence of at least three other terrace levels in the face of this profile.

11. Though the government outlawed the manufacture of sun-dried mud bricks in the mid 1980s to halt the waste of valuable topsoil, most village buildings continue to be made of these traditional bricks. In the earlier part of this decade it was common to see large areas commercially devoted to sun dried brick manufacture. Today production is more generally limited to personal use and manufacture takes place at the family compound. The topography of the Fayoum is scarred with numerous deep indentations along drainages and canals where past topsoil and clays have been "scooped out" for brick production. Today, fired brick and cement factories operate on the northeastern desert edge of the Fayoum along the road to Cairo.

12. Located along the main road between Medinet al-Fayoum and the village of Demo.

13. It is interesting to note that of the 5 police reports summarized in Mehanna et al's monograph, 2 were reports citing the Irrigation Police as the perpetrators of wrong doing or improper actions. This indicates a high sense among irrigators that the state, or Irrigation Police meddle in areas where they didn't belong.

14. Egypt is considering a variety of approaches to solving the problems of insufficient drainage works. There are a number of projects throughout Egypt that are tiling drainage canals to retard current waterlogged conditions.

15. This increased salinity is the result of increased evaporation rates for water standing behind the Dam. Waterbury cited increased levels in the late 1970s of around 10%, where "water entering the reservoir has about 200 ppm [salinity], and when it leaves, 220 ppm (Waterbury 1979:143).

16. Abdou et al. concluded that,

> The probability of violating the mandatory cotton area allotment tends to increase by only one percent for a one-feddan increase in land holdings and tends to decrease by about 18%-20% for a one kilometer increase in the distance to market. Increasing expected government prices by one L.E. per cantar would tend to decrease the probability of violating the mandatory cotton area allotment law by 10%-12%. (Abdou et al. 1986:126)

17. In the Fayoum, water, "flows to agricultural land continuously throughout the year except for 18 days (from 11th - 29th January) when the whole system is closed for maintenance and repairs" (el Quosy & el Guindi 1981:13).

18. During the second week of al-gafaf I traveled to Luxor in Upper Egypt and had the opportunity to observe the some differences in gafaf labor there. In the village of Guerna most of the gafaf labor concentrated not on dredging, but on cleaning plants from canals.

19.) Egyptian irrigation systems outside of the Fayoum can function adequately despite a high degree of neglect. Adams reports that near Zeer "most of the floodgates are broken and the watchmen have nothing to do but collect their salaries" (Adams 1986:113).

CHAPTER 11
CONTEMPORARY IRRIGATION IN THE FAYOUM: THE VILLAGE

The Ethnographic Setting

I arrived in Egypt in July 1990 and lived in the Fayoum from August 1989 to July 1990 outside of Madinet al-Fayoum in Keman Faris.[1] I studied the irrigation practices of farmers living and working in the fields surrounding my house, as well as those in four separate irrigation networks located in different areas within the Fayoum. I decided to study separate irrigation groups in different areas to determine if the different micro-ecological settings (e.g., different elevations and water delivery rates) and the accompanying technologies of water delivery had discernable impacts on the economic or social formations of these villages.

The general economic and social formation of each of these villages was very similar. Each had a predominantly agrarian economic base; each was constrained by the same governmental cropping and irrigating requirements; each had its irrigation water allocated and supervised by the Ministry of Irrigation. The economic and social condition of these villages is in fact generally similar to those found in the villages of Upper and Lower Egypt. Families are large, land holdings are small, agricultural production is predominant and labor intensive (Abd al-Hakim 1953). The state insists on becoming involved in the regulation of crops grown and collecting taxes. These are the generic conditions that face fellaheen engaged in agriculture throughout Egypt.

I studied the organization and practice of irrigation in five different villages spread throughout the Fayoum. Each of the five villages were chosen for its representivness of a particular feature of Fayoumi irrigation. These particular features were both ecological and technological (method of water lifting). Qasr al-basl was selected because of its location along the edge of the Fayoum's cultivation zone and the surrounding desert (conditions which necessitate its reliance on pumps for water lifting). Keman Faris was chosen because of its recently reclaimed lands as well as long farmed lands and its mixed reliance on undershot waterwheels, saqiya, and gravity. The fields surrounding Naqalifa and Sanhour are excellent examples of gravity-fed, saqiya and undershot waterwheel orchard (as well as other crops) sites. Shakshouk was selected because (like qasr al-basl) it is a marginal agricultural site because of its location along the shore of Birket Qarun.

In many ways there is a great commonality to life in these different Fayoum villages, just as there is much in common with lives of the fellaheen living in villages along the Nile Valley and Delta. There are commonalities of agricultural life, demographics, inheritance, marriage patterns, and political views of the larger Egyptian state. Daily activities were organized around the needs of agriculture, irrigation schedules and (during spring, summer and fall) avoiding the heat of the day. Irrigation activities among all but the pump groups are dictated by set schedules requiring some farmers to irrigate even in the middle of the night. Planting, weeding, furrowing, harvesting, fertilizing, thinning, pest controlling, plowing, leveling and other forms of crop tending are done in the mornings and later afternoons, the middle of the day is generally spent at home, or in the shade near fields resting.

Men, women and children all engage in agricultural related labor, though men are far more active in the fields than are women. Irrigation related activities in the Fayoum are predominantly male activities. Women do occasionally assist in irrigating despite claims from informants that women are never involved in irrigation activities (similar findings in the Fayoum were also reported by Prentis 1985:13). Men are generally in charge of the management of agricultural activities while women and children tend to function as laborers. The main exception to this rule is the women's dominant role in livestock management. Women are generally responsible for the care and feeding of chickens, geese, goats, sheep, as well as pigeons kept in the large pigeon houses (hammam).[2]

Not all fellaheen in the Fayoum own the land they farm. In the irrigation communities I studied about a quarter of the plots' were farmed by tenants. Contracts and agreements between tenants and owners are regulated by National tenancy laws setting rental limits at 7 times the land tax rate. Land taxes are generally collected at the rate of L.E. 10 per feddan, thus the going rate for renting farm lands is about L.E. 70 per feddan.[3] Tenants are responsible for managing lands in accordance with the wishes of the state, as well as irrigating within the preexisting framework of the local munawaba groups (as discussed below).

Throughout the Fayoum there are few technological options for the problems of post-harvest production. Most farmers move their harvests (or harvest bi-products such as stalks) with camels, donkeys, horses and occasional on a rented truck. These animals are used to draw carts, or they are loaded with open "saddle bags" woven out of palm fibers. Produce is moved to homes, and is often transported to the market place on local service or with animal power.

Weekly markets are still an important part of fellaheen lives. Each of the five markez in the Fayoum operates a centralized market one day each week--for example, Medinet al-Fayoum holds its market every Tuesday. There are also smaller weekly markets spread throughout the countryside (see Larson 1982). The larger markets are dominated by livestock. Cammels, donkeys, water buffalos and sheep take up a large area every week while off to the side (and often at different localized settings) women and men crouch in front of stacks of fresh vegetables, tanned animal skins, farming tools, and palm woven grain saddles for donkeys. Most of the items needed for agricultural production can be purchased at these markets. Though women often care for livestock, men are the agents who dominate the actual buying and selling of these animals. The market in Medinet al-Fayoum even has its own snake oil salesman who mixes prestidigitation with Quran sworn testimonials as he hawks small plastic vials of "heat balm" to large crowds of fellaheen, whose muscles no doubt ache from their labors. The smaller markets are usually dominated by vegetables.

In the 1940's a network of small-scale cable cars connected many of the villages in the Fayoum Depression with Medinet al-Fayoum and Beni Sueif. This system of cars and rails was dismantled during the late 1950's even though it was a widely used method of transporting goods to marketplaces. Much of the rail-grade surface was converted to roads for automobiles and busses. Today, the limited rail which runs along an east west corridor is used for transporting small amounts of goods to local markets, and sometimes for transporting goods to Beni Sueif along the Nile.

Tractors are rarely owned by individuals. Those who do own them rent them out to individual farmers on what is usually a daily basis, and receive payment as either a share of the crops or money. Payments of one or two Pounds are always made to tractor drivers. Most tractors are built in Eastern Europe, though there are some American built tractors as the result of U.S. backed aid programs.[4]

Through the practice of double cropping (and occasionally triple cropping in areas dominated by pumps) Fayoumi farmers significantly increase the number of individuals an area of land can support. Of course the cost of this benefit is the very real possibility of completely depleting the soils used for farming. Add to this the reckless manor in which chemical fertilizers and pesticides are used and it is only a matter of time until large areas of the Fayoum will not be farmable.

With the current levels of state intervention in everything from cropping decisions to irrigation options, one of the few choices left open to these Fayoumi fellaheen is the choice of family size--though many individuals would insist that it is not they, but God, who would decides the size of their families. Large families are sought after for a variety of emic reasons. Foremost in explanations of why large families are preferred is a nostalgia felt for having grown up as a member of a large household. The Quran is

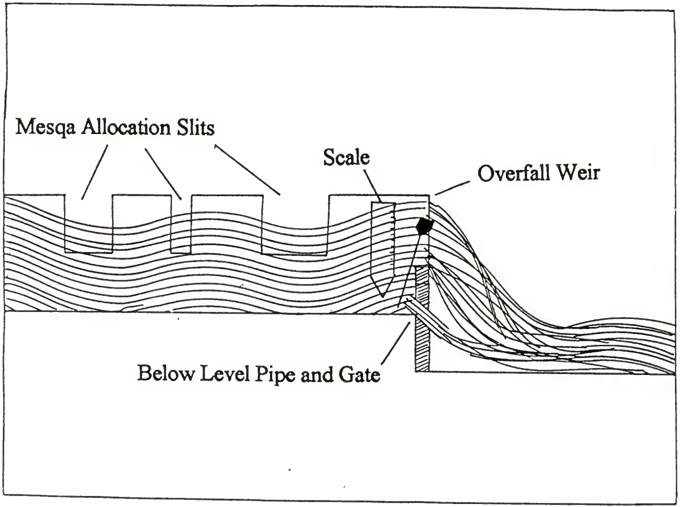

Figure 11-1. Sketch of Fayoumi Weir.

also interpreted to encourage the production of large families.[5]

Like the rest of rural Egypt, Fayoumi villagers have large families. The mean family size for Fayoumi villages is 9.5. Birth control pills and condoms are available at most village pharmacies at prices subsidized by the state, but high fertility rates are rule rather than the exception. Labor demands, and perceptions of labor demands would seem to be the best explanation for the large size of families.

Local Water Lifting Technologies of the Fayoum

As indicated in the previous chapter, once irrigation water reaches the local mesqa, the primary responsibilities of the state are completed (though their secondary responsibility of irrigation enforcement is just beginning). Beyond the last mesqa, the local farmers are responsible for the actual delivery of water to their fields, a process generally involving some method of water lifting.

Fayoumi farmers employ four water lifting techniques: 1) direct gravity flow, 2) saqqiya--powered by gammosa or donkey, 3) waterwheel--undershot lifting water-wheel, 4) portable gasoline or kerosine powered pumps.[6] The distribution of water delivery devices throughout the Fayoum can be broken down approximately as follows:

30% Gravity Alone
20% Undershot Waterwheels
35% Animal Driven Saqqiyas
15% Internal Combustion Pumps

This is only an estimate because the Ministry of Irrigation could not or would not make any such statistics available to me, though numerous officials did agree with the general makeup of this rough estimate.[7]

A number of factors determine which method of water delivery is used to bring water to a particular field. The single most important factor is elevation, or more specifically the regional location of a plot of land. In general, plots located at the upper elevations and desert edges of the eastern Fayoum rely more on internal combustion lift pumps than those lower lands of the interior and western regions. The bulk of undershot water wheels are located in areas between +15m and -10m elevations where canal engineering has kept canal flow elevations high enough that a head exists to drive an undershot wheel. The widespread use of direct gravity flow tends to be found in the central and western areas of the Fayoum. The animal driven saqqiya is found throughout the Fayoum and does not seem to be more prominent in one region than another.

As figures 11-2 and 11-3 illustrate, the different regions of the Fayoum are marked by differences in the dominant forms of water lifting technologies. Lands located where the depression's decline is insignificant--such as the

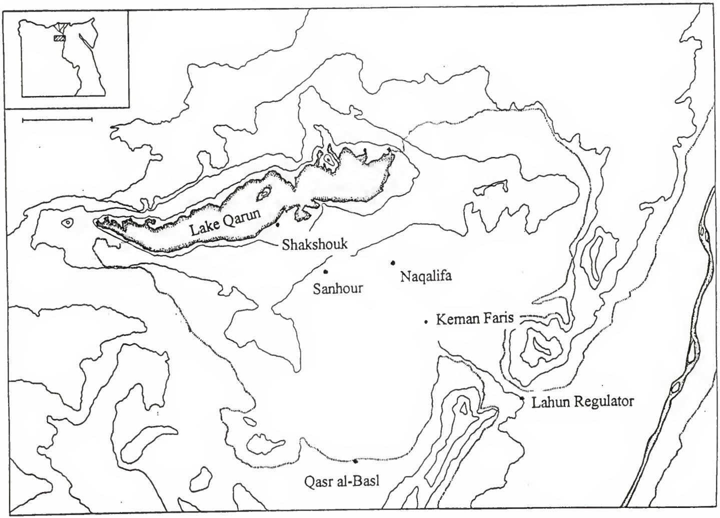

Figure 11-2. Fayoum Overview Showing Study Sites.

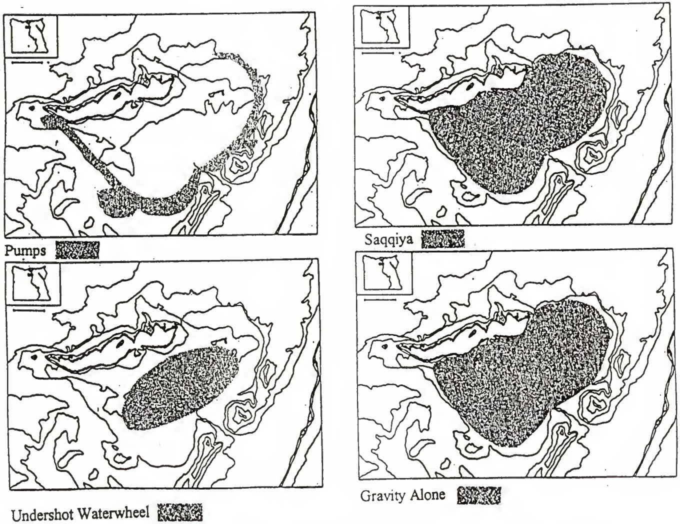

Figure 11-3. Distribution of Dominant Forms of Water Lifting Technology Throughout the Fayoum.

eastern Fayoum and regions along the depression's edge--are overwhelmingly reliant on pumps for water lifting. In the Fayoum's central region undershot waterwheels are most frequently found. The central and western regions of the Fayoum also have the widest use of gravity-alone. Animal drawn sagiya (norea) are used throughout the Fayoum.

Direct Gravity Flow

The Fayoum's steep natural gradient allows for more of its lands to be irrigated without the use of mechanical water lifting devices than could be done along the Nile Valley. The Fayoum Depression's location below sea level allows for gravity-fed water to be delivered directly to many of the fields, or at least to canals that surround the fields. The depression slants downward at a rate of 7 meters every kilometer from the east to the west.

Gravity-fed irrigation sets the Fayoum apart from the rest of Egypt. All irrigation in the Fayoum relies on gravity flow for at least the delivery of water to the region through larger feeder canals. In the final instance water may be lifted to fields by pumps or water wheels, but the bulk of the water's journey from the Nile is always accomplished via gravity flow. Gravity-fed irrigation is differentiated from other irrigation methods by its reliance on canals and elevated topography for the delivery of water. Flood basin irrigation systems, for example, are not effected by the same type of allocation issues as are gravity-fed systems because upstream/downstream relations are not as important as are issues associated with flood.

Some fields located near declining contours in the central and western Fayoum are able to rely solely on gravity for the delivery of water to their fields. Canals in these areas are adapted to the contours in such a way that water flows slightly above the level of surrounding fields. When a farmer's scheduled time for irrigation arrives he simply opens a mud passage and lets the water flow onto his field.

Saqqiya (noria)

The saqqiya (or noria) was introduced to the Fayoum by at least the Ptolemaic era (see chapter 6 for more discussion of questions concerning the introduction of the noria). The cattle driven Saqqiya is used throughout Egypt and north Africa for raising water from canals to fields (see figure 11-4).[8] There are often shaded areas next to the saqqiyas for the men or children who supervise the animals driving the saqqiya.

The Fayoum countryside has thousands of small huts or shady arbors. Some of these structures are located at the intersections of plots of land, and many are situated in proximity to a munawaba group's (irrigation group) shared saqqiya. The ground surrounding these huts is often swept flat and covered by palm fronds. These huts serve as a lounging area for individuals who are irrigating, waiting to irrigate, or simply wishing to socialize with others who are irrigating. It is not uncommon to see groups of six to a dozen men sitting or laying around in the shade of this shelter while a water buffalo lifts water to a field.

There are many different behavioral strategies used by irrigators. The most common involves one irrigator staying at the saqqiya and making sure that the traction animal (usually a gamousa) maintains a steady pace of turning the wheel. Another individual (or two or three) goes out to the actual plot of land which is receiving the water and manipulates the soil ridges to allow for the best possible watering. This second person wades about as the water floods the plot and "tinkers" with the plants and mud retaining walls of the field.

When the allotted time has passed, the irrigators open a portion of the field's retaining edges and let the water drain out into a drainage canal. If there is an individual who immediately follows in the irrigation cycle at the same saqqiya, they frequently prod the last irrigators to hurry up so as not to cut into their allocated watering time. In the contemporary Fayoum, three varieties of the actual water lifting device on the traction saqqiya are still in use.

All three varieties of the saqqiya have the basic mechanical design feature of a central vertical shaft attached to a horizontal yoke-beam to which a draft animal is harnessed. The mechanics of the saqqiya are simple. A single animal (usually a gamousa, or sometimes a donkey) is harnessed to the end of a long shaft of wood extending from a central horizontal axis. These animals are generally blindfolded with thick eye patches as they walk in circles, pulling their harness. As the gamousa turns, the horizontal beam rotates a cast-iron horizontal gear at its base. This horizontal gear in turn rotates a vertical gear which finally powers the gear connected to the actual water lifting mechanism, most commonly a large sheet metal water lifting wheel.

These sheet metal saqqiya have the appearance of two large circular saw blades connected together by paddles joined at the center. As this large disk rotates, water is scooped up and falls to the center of the disk as it rotates. As the wheel turns, it draws all the water to ward the hub where it is drained away from the saqqiya by a pipe to an irrigation ditch. This water is drained away from the saqqiya at an elevation about 1.5 meters higher than when it first encountered the saqqiya.

There are occasional maintenance costs which are shared by the individuals who share the saqqiya, but the primary costs associated with this mode of water lifting are those of raising and maintaining a source of traction power.

Irrigators using the saqqiya either own the traction animal used for lifting water or they must make "rental"

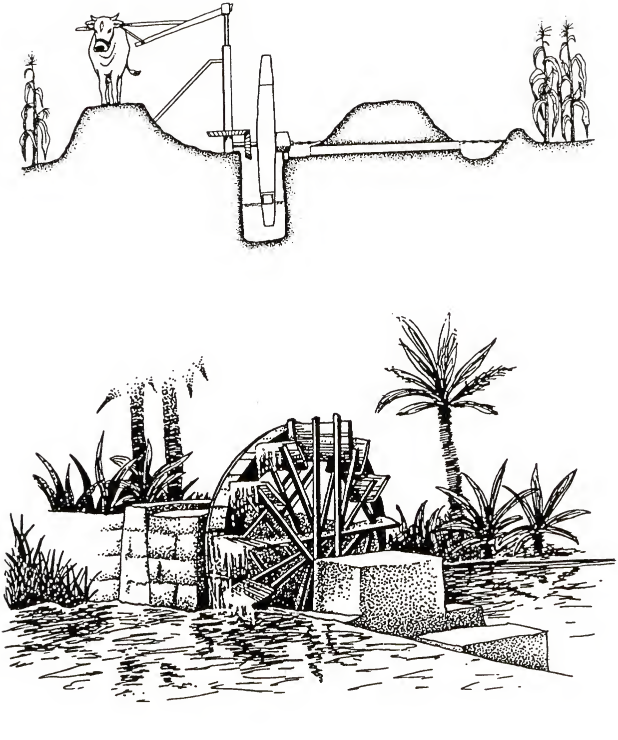

Figure 11-4. Animal driven saqqiya and undershot waterwheel saqqiya.

arrangements with an animal owner. Payments for the use of a gamousa to power a saqqiya are made in either cash or bartered goods and services. A common monetary payment for the use (2 hours) of a gamoosa is L.E. 2. Animals are seldom left unattended while they are harnaced to the saqqiya. Children are often left to watch over the animals and to occasionally prod them on with a stick or switch. Sometimes an irrigator or household member will take a nap in some nearby shade while keeping one ear tuned to the constant squeaks of the turning saqqiya. It is common to see groups of a half dozen men sitting or sleeping in the shaded areas near their shared saqqiya.

There are still many saqqiya in use of more ancient design. The basic designs are the same as the modern metal wheeled saqqiya, except for the actual lifting mechanism. Some use either chains and wooden buckets or rope and fired clay pots to lift the water. The buckets or pots are raised in an oblong circle, as they crest and begin their inverted descent the water spills into a catchment trough which flows to the raised irrigation ditch. These lift less water and seem to be more frequently operated by donkeys than do the modern sheet-metal saqqiyas.

Repairs and maintenance of the actual saqqiya are arranged and financed by the saqqiya group. During the gafaf period when no water is available, the saqqiya group will inspect the saqqiya and commonly lubricate its drive shaft by packing them with animal fat.

Saqqiya Undershot Water Wheel

The undershot water wheels are also simply known as saqqiya (see figure 11-4). In common usage, there is not a linguistic differentiation between the undershot wheel and the animal driven saqqiya (noreia). All undershot wheels in the Fayoum are basically of the same design and construction, though there were three different wheel size diameters: approx. 3-5 meter, 7 meter, and 10 meter. Of these the most common is the 3-5 meter wheel.

The undershot waterwheel is ubiquitous to the Fayoum. It has come to symbolize the region. The seal of the governorate is even represented by an undershot saqqiya waterwheel. The sounds of the wheel's continual squeaking can be heard in the background throughout the central depression. The city of Fayoum is known as "the city of seven wheels." These seven wheels can be seen today along the banks of the canal Bahr Sannuris north of Medenet al-Fayoum. As discussed in chapter six, the undershot wheel was most likely introduced in the Fayoum during the first century A.D.

The undershot wheel lifts large volumes of water without the costs of energy and maintenance associated with traction animals or internal combustion pumps. Undershot wheels are situated along canal banks in positions where the water plunges down small water falls from 30 to 70 centimeters. This drop in water-level increases water pressure and catches the wheel's paddles forcing the wheels to rotate. Sites with undershot wheels may have one to four wheels at one spot.[9]

The design of all the Fayoumi undershot wheels is essentially the same, regardless of its specific dimensions. The wheel has a central wooden hub attached to a free-spinning axle. Under-shot wheels are generally about 2 meters in diameter, and have a width between 40 and 50 centimeters.[10] They have a large wooden axle running through their middle to large support stands on each side. The rubbing of these wooden axles creates a strange howling noise that can be heard throughout the countryside.

Twelve to 20 paddles surround the edge of the wheel and catch the water flowing beneath it and pull the wheel forward with the current causing the entire wheel to continuously rotate. Box like chambers sit along the rim connected to each of the paddles. Each of these boxes has an opening on its other side through which water rushes in while the "box" is submerged, and a out of which water rushes when the paddle and "box" begin their descent into the Bahr again. The water spills out of the boxes at a continuous rate spilling into troughs at the sides of the wheels. These wide troughs are made of stone, wood, brick or cement and carry the water away from the wheels to ditches and fields.

At times the paddles on these wheels break down. On one occasion a single paddle on an undershot-wheel supplying a field near Keyman Faris became damaged by some large floating object. From this minor amount of damage, the whole wheel was in jeopardy. Because the efficiency had been so greatly reduced, and a greater strain added to the reciprocal parts of the wheel, both wheels were rapidly degenerating and if they had not been repaired soon they would have been torn apart by the force of the flowing water. The local irrigation group decided to lift the entire wheel from its position and effected the need repairs and then return the wheel to its position. This process took over three days and in the end the wheel was not properly fixed until January during the time of gafaf when the flow of water ceases and repairs could be completed without the disruptions caused by the constant flow of water.

Pumps

The pumps used in the Fayoum are owned either by the individuals who use them, or are owned by a single individual who rents out pump time, rather than collectively owned as is the pattern along the Nile proper (Hopkins 1987:100; Mehanna et al 1984). These are small, portable two-stroke pumps of Japanese manufacture that run on gasoline. Nile Valley irrigation social organization is primarily organized around pump cooperatives. These cooperatives share the costs of pumps, their maintenance, and work out time sharing schedules for their use. Unlike the Nile Valley irrigation in the Fayoum as a whole does not depend on pumps for lifting water.

The price of a small portable pump ranges from L.E. 900 to L.E. 3,000. Their hydraulic output varies from approximately 0.5 to 2.0 lps. Some farmers supplement water lifted by water wheels or saqqiyas by using small pumps. This is done without consulting contiguous neighbors, or officials from the Ministry of Irrigation.

Pump user-groups are less formally organized than the gravity-fed munawaba irrigation groups. Schedules are also much more flexible, the limiting factor for these groups is more access to pumps than a limitation of water. This of course presents these groups with more of likelihood to waste water and over irrigate their crops. Fayoumi pump based irrigation groups do not compensate downstream irrigators with magrur calculations. Instead individuals are left to pump as much water as their access to the pump will allow.

Other Lifting Methods

The Archimedes screw (tunbur) is only occasionally used in contemporary Fayoum.[11] The tunbur consists of a tube ranging in length from two to four meters. Inside the tube is fastened a non tapered screw with a crank handle affixed to the upper end of the tube. The tube is placed at a perpendicular angle to the water, resting along the mud lip of the bank and rotated by turning the handle. As the handle is turned, the water inside of the tube is lifted along the lip of the screw. Eventually the water reaches the top of the tube and spills out into the field or canal below. In the Fayoum the <u>tunbur</u> is rarely used. Some farmers use it to supplement their normal water allotment during crucial periods of their crops growing schedule.

I know of no instance of a farmer relying on a <u>tunbur</u> as the sole means of water procurement. Its usefulness seems mainly to be found in the hands of water thieves. Its portableness and relatively silent operation allows for thieves to insert it in feeder canals, up-flow from users and to divert small portions of water without detection. I never observed this, but different informants insisted the <u>tunbur</u> was responsible for a reduction of water in the canals. One informant from Qasr al-Basl showed me indentations along the lip of the canal and damp soil as evidence a neighbor had robbed him the night before during his time of irrigation. When asked if he would confront his neighbor, he said no, he would wait and catch him in the act the next week. The following week however the neighbor did not (apparently) steal any water so, other than a small amount of bickering between the two, the matter was dropped.

The _shaduf_ is the oldest water lifting device in Egypt, dating back at least to the Old Kingdom (Butzer 1976). The simplest _shaduf_ consists of only a pull with a counter weight on one end, a balanced axle, and a water bucket at one end. The basic principle of operation is that the counter weight eases the burden of lifting the bucket full of water. I never saw a _shaduf_ anywhere in the Fayoum. All farmers I asked, said they knew of the _shaduf_. Most said its use was limited to the Nile valley, or specifically the _Sayeed_.

Each of these water lifting methods has influenced the structure and function of the irrigation groups dependent upon them. It is for this reason that the different irrigation groups I studied were dependent on different methods of water lifting. Each of the five villages that I studied relied on different water lifting technologies, and these differences were evident in the ways they used irrigation water. Below, each of the five different settings are briefly described.

The Five Villages

The five Fayoumi irrigation groups I studied were located near the villages of: Keman Faris, Naqalifa, Qasr al Basl, Sanhour and Shakshuk. Each of these communities was selected because of their slightly different environmental features (primarily different elevations), which lead to different water lifting and delivery methods. These irrigation communities used the full variety of water lifting devices found in the Fayoum: gravity-fed canals, pumps, undershot waterwheels and saqiyas. I was interested in seeing if these different settings and technologies had resulted in different irrigation strategies and practices. All in all the general features of cultural and familial life are similar throughout the Fayoum's rural countryside. There are however specific differences in the methods of water delivery to farmers fields which necessitate different labor inputs and different forms of organization. Below each of the five field settings are described and information on their method of water delivery is given.

Keman Faris

Keman Faris is located just outside of Medinet al-Fayoum, the largest city and governmental administrative center of the Fayoum. Keman Faris is a modern housing development located on the site of ancient Crocodilopolis (Arsinoe), the central city of the Fayoum from Dynastic, Ptolemaic, Roman and Medieval times to the present. Almost nothing remains of this site which was once described by Lepsius as the largest occupational mound in all of Egypt (see Kees 1961:229).[12] The few ancient architectural remains left today will be obliterated in the next few years, to make way for more poorly constructed apartment buildings. In 1990 there were two beautifully preserved Roman baths still in existence, the hollow heat baffles beneath the western-most provided a den for a family of desert foxes (see al Khachab 1984).

The ecological setting of Keman Faris exemplifies the features of the central Fayoum depression. Terracing is slight and the general lay of the land is primarily flat open field crops with scatterings of date palms at the barrier edge's of individual holdings. The central Fayoum depression has the greatest frequency of saqqiya undershot waterwheels, though there is also still a general reliance on the animal driven saqqiya for the lifting of irrigation waters.

Irrigation water is delivered to the fields of Keman Faris by both gravity and animal driven saqiya depending on the specific location of a plot of land. The regional irrigation network groups (munawaba) are small, usually having between 12 and 25 members. All irrigation at Keman Faris follows weekly schedules in which irrigators water their fields at the same time each week, unless arrangements to the contrary are negotiated with effected munawaba group members.

The area of Keyman Ferris was transformed into agricultural land during the middle of this century due partly to the fellaheen depleting the tell looking for sebbakh (the agriculturally rich decayed debris found in archaeological mounds)[13] and partly as a means of expanding the supply of available farm land. Debris (mostly decayed mud brick) from the mound were mined, loaded on donkey carts, and hauled out to the sandy and marshy edges of the tel where it was spread out as new top soil. It is interesting that even in this recently reclaimed area, the form of the plots and fields are similarly shaped in their irregularities with the long standing surrounding plots.

If all the architectural remains and limited statuary of Keman Faris disappeared, its archaeological past would still be apparent by the pottery matrix strewn through out the fields and irrigation ditches. Most of the shards are no bigger than three or four centimeters across, though there are plenty of larger (20-30 cm.) shards. Artifacts are everywhere. When one walks along the trails between fields and looks into the matrix of the small "terraces" built up to make one plot higher than another there are wasters, jug handles, rims and bases of pots exposed. Most of it looks to be Roman and Ptolemaic.[14]

The belief that the shards are a hinderance to farming is hard to rectify. Given that there are only sparse scatterings of shards, the surface area of the soil is not really reduced. There may actually be an increase in percolation action caused by the shards, with the high water table of the Fayoum (often 50 to 100 cm. below the surface) the increased downward movement of water is a welcome feature (see Miller 1977:373-389).

Artifacts from past occupations are also used in other ways by the local inhabitants. Bases of columns or pillars are used as property cornerstones, temporary dams for diverting canal water, or as grinding stones in fellahin houses. Cut stone blocks and even Roman fired bricks are used in the construction of homes. In the past, it can be assumed that large portions of the local tel were desecrated in search of mummies and papyrus which could be sold to Europeans as was the case through out most of Egypt during the last 100 years (see Fagan 1975; France 1991).

Some farmers rely on "day laborers" to help them farm their crops in Keman Faris. Some of these laborers are hired from the immediate area while others are hired from in the city of Fayoum. On most mornings groups of men gather at the intersection of Mustafa Kamil street and the Bahr Yusef Canal in downtown Fayoum and sit with their hoes and other farming tools. Trucks will drive up to this area and hire a few laborers at a time.

The crops grown in the around Keman Faris are field (rather than orchard) crops such as cabbage, tomatoes, onions, peppers, wheat, sugar cane, cotton, rice and corn. Very little mechanization is involved in farming this region. The ground is usually prepared with a water buffalo drawn plow and crops are most often brought to market on animal drawn carts (though sometimes trucks are used).

Qasr al-Basl

Qasr al Basl is a farming village located on the south east desert edge of the Fayoum. Its name literally translates as "palace of the onion", though the Basl ("onion") refers directly to an important lineage in the region, not to a vegetable. The common crops of this area are wheat, beans, peppers, cabbage, and (of course) onions. The Tharwho Canal runs through the village, marking the edge of the eastern cultivation zone. Qasr al-Basl is the site of some state sponsored dessert land reclamation projects.[15] There are no orchards or vine crops, except for the date palms bordering fields all crops in this area are field crops.

Qasr al-basl's location along the desert's edge underscores the Fayoum's longstanding relationship with Bedouin. In the contemporary Fayoum, principles and practices of lineage-based "tribalism" do not play an important role in the organization of the political economy. The structures of the patrilineal descent system are in place, recognized and used by Fayoumi villagers, but these structures have a secondary importance to the political structures of the state.[16]

Qasr al-Basl's relatively high Fayoumi elevation necessitates the primary use of pumps for irrigation. Pumps are for the most part individually owned. The use of all pumps for irrigation is organized through groups similar to those that organize gravity-fed irrigation elsewhere in the Fayoum. There is no (magrur) compensation made to irrigators for water lost in transit. The irrigators of Qasr al-Basl have a greater flexibility in their access to water than the other irrigation groups I studied. Irrigator's in Qasr al-Basl who feel they need more water instead have the option of pumping as much water as they want, the constraint being their own access to a pump.

Pumps in Qasr al-Sagr are either owned by individuals or by groups of two or three investors. Pumps are rented from owners at rates of about 2 L.E. per hour. Farmers usually coordinate their irrigation with owners of surrounding fields so that water lifted to conveyance canals is not wasted.

Naqalifa and Sanhour

Naqalifa and Sanhour are discussed together here because of the overall similarity of the conditions for irrigation and agriculture in both of these communities. Naqalifa was the site of Mehanna, Huntington and Antonius' 1984 anthropological and irrigation study fieldwork. Their study was comparative not within the Fayoum, but with the whole of Egypt.

Munawaba groups oversee the local distribution of water in this region. Water-lifting in the field's surrounding Naqalifa and Sanhour relies on gravity, saqiya, and undershot waterwheels. To the north of Naqalifa a ravine cuts through the countryside, producing actual waterfalls and increasing the water current which has been used in the past for driving small, locally owned grain mills. These sharp drops and inclines allows the widespread use of gravity-fed irrigation in this region. Water canals are contoured along embankments, and then kept at high levels above fields to avoid the necessity of water lifting downstream.

Naqalifa has a population of approximately 12,000 inhabitants and is a good representative of the central Fayoumi village setting. The Fayoum's contour near Naqalifa allows for some of fields to be irrigated by gravity alone (i.e. no pumps or saqiya are needed). The ease of water lifting in this region of the central Fayoum has turned it into a green belt of orchards, vineyards and fieldcrops.

Sanhour is located to the west of the central Fayoumi green belt. The town of Sanhour is surrounded by orchards as well as field crops. Grapes, lemons, mangos, and oranges are the predominant crops grown there. Sanhour's rich soils are the product of the rich sediments it received from having been located just below the shoreline of Lake Moeris until the Roman period.

Sanhour was the site of political unrest during my stay in the Fayoum. Sanhour has an above average number of christian inhabitants. Out of a population of 15,000 there are an estimated 1,500 christians. A number of hostile incidents occurred between muslims and christians. At one point, Egyptian solders were injured from a bomb which exploded while they were guarding a Coptic church. The bomb was tossed from a passing motor cycle, which everyone assured me had been driven by members of either the Islamic Brotherhood or the Jihad group. I also witnessed the beating of a christian man in a public place by muslims. When I tried to see what was going on I was escorted away from the area into the back of a servece taxi and told to leave because the police were coming.

The overall ecological and hydrological setting of Sanhour is similar to that of nearby Naqalifa. The orchards and fields are predominantly supplied with water by gravity, though the saqiya is also used. As elsewhere in the Fayoum, munawaba groups oversee the local distribution of irrigation water.

Naqalifa and Sanhour are both located in the midst of the Fayoum's orchard region. Orchard crops are the most highly valued (legal) crop in the Fayoum.[17] Orchards require more water to maintain life, but the ministry of irrigation will not allow for an increase in water allotment until an orchard is in its second or third year. Farmers wishing to plant orchards use a variety of techniques to survive during the crucial early years of their orchards' lives. Those who own other plots let land lie fallow and divert water to the young orchards (thus exerting the influence of capital to increase their earning power): others "borrow" irrigation time from others or simply steal it. Orchards tend to be located near at the top-end of canal networks. I found that for five munawaba groups I examined near Naqalifa, and the four near Sanhour, the further one travels down a canal the fewer orchards are encountered.

Farmers who rely on orchard crops have higher returns for labor per area of land than do tenders of rotational crops. A producing orchard receives half again as much water as do plots with non-orchard crops since the Ministry of Irrigation allows orchard farmers an extra fifty per cent share of water per feddan. Farmers are very much aware of this but they do not all quit their rotational crops in favor of orchards because of a number of limiting features.

First, they are not allowed extra shares of water until the trees are in their 3rd year of life. Farmers must apply to the Ministry of Agriculture to change the status of their land. This process is in itself is a sort of catch 22. The first four years of life for citrus trees are fragile ones. If water shortages occur they can easily die. During these first years of orchard farming, there are no profits at all coming in from the lands. Few farmers can subsist off of wage labor while their orchards are maturing. Even those who could afford this option are swayed against it because of the risks of failure. As with most peasants the world over the Egyptian Fellaheen are conservative in their risk taking.

Farming orchards requires different work patterns than other crops. During much of the year little labor is required. Most pruning and weeding of fields occurs in the harvest season. Most farmers pick their orchards a number of times, selecting only the fruits at the desired ripeness depending if he is going to sell the crop locally or in Cairo.

There are a number of different strategies farmers use to break into orchard production. One individual near Naqalifa told me his father had planted his 5 feddan lemon orchard ten years earlier while he was working in Saudi Arabia as a waiter. His father had planted the orchard and farmed it for its first few months and made sure his teenage son tended it in his absence. His family subsisted on money from their father's remittance during the first crucial years of the orchard's growth.

Most farmers plant crops such as tomatoes, potatoes, hot peppers or fava beans between the rows of young orchards (of citrus or olive trees) so that some level of productivity is achieved while they are waiting for the trees to mature. It is rare to see a young orchard growing without some crop planted between its rows so that some return can be realized in the interim between the planting and production of their trees.

Farmers owning large plots of land who wish to increase orchard production have a number of options poorer farmers do not. They can let a plot go fallow for a year and divert that land's water share to new orchard lands. If they own enough land this can go on for years just by rotating which lands are fallow.

As with other areas within the Fayoum, Munawaba group members of a high rank can also manipulate the water schedule to facilitate their particular needs on a week by week basis.

When a number of plots have been converted to orchards for three months the ra'is al-munawab reports this to the Ministry of Irrigation. When a significant number of fields in a region have been converted to orchards the Ministry of Irrigation will widen the supply weir to increase the flow of water. Farmers and individuals from the Ministry of Irrigation were vague about the requisite increase in converted plots before the Ministry would widen weirs. Mehanna et al. reports,

> Basically, there are no restrictions on such transfers [from field crops to orchards], but one of the conditions for acceptance by the Ministry is that an agronomist of the Agricultural Credit Cooperative must come and evaluate the size of the area that is switched. (Mehanna et al. 1984:102)

Though farmers are free to try and convert fields to orchards, in the last instance it is the discretion of the state which determines if increased waters will flow to these plots.

Shakshouk

Shakshouk is a farming and fishing village located on the southeast shore of Birqa Qarun. Shakshook has a population of (approximately) 10,000 people. A variety of field and orchard crops are grown near Shakshook. The lands in this region are fertile where they are not suffering from the effects of over-salinization.

The village of Shakshouk could not have existed until at least the 5th century A.D. when shore levels of Lake Qarun had dropped to near their current levels. Prior to this time (except for periods of complete dryness during the Neolithic) the lands around Shakshouk were only the submerged sediments of Qarun's lake bottom. The land is for the most part fine sedimentary loam, though a higher percent of the land is lost to salinization than in the other villages studied in the Fayoum. This is due to both the character of the irrigation water by the time its traveled through the oasis, and the amount of saline water which seeps from the salt waters of Lake Qarun to the surrounding fields.

Irrigation near shakshouk relies on gravity, the saqiya, and pumps for water lifting. Munawaba groups are responsible for the local distribution of irrigation water in Shakshouk. Most landholdings are small, many are only a feddan or two in size. Because many families are engaged in fishing this does not present insurmountable subsistence problems.

Most households are at least partially supported by fishing or shrimping. The varieties of fish include: bolty and catfish. The boats of shakshouk are small brightly painted keel-less, single masted falookas (approx. 5 meters in length). There are a wide variety of wind patterns, ranging from gales with white caps to calm water.

The lands surrounding Shakshook have high rates of salinization. There are patches of completely unfarmable lands whose waterlogged surfaces are marked with a white crust of salt. During the winter months many of these fields are inundated by the excess waters flowing into the region. The water delivered to these lands along the shore of Lake Qarun has higher salinity contents than lands located up-canal (el-Quosy et al. 1981). This is due in part to up-canal farmers dumping used irrigation water into the main irrigation canals.

In the coming years--if Shakshook can avoid the potential inundation of Birqa Qarun's rising waters--this village will no doubt be inundated with tourism. Except for three small hotels, the shores of Birqa Qarun are presently undeveloped. Shakshouk and all of the area surrounding the water front of Lake Qarun will no doubt undergo radical commercial development in the next decade. The surrounding agricultural fields will give way to condos and luxury hotels. The lake's nearness to Cairo makes it a logical area for commercial development, and the beautiful sunsets over the lake's Libyan Desert shores makes it an area developers will not be able to resist. The Aberge Hotel was once a royal summer palace for Egypt's monarch, and later served as the site for the post World War II meeting between Winston Churchill and King Saud where--five days after his meeting with Stalin in Yalta--political agreements were established concerning the political and geographical status of the post-war Arab World (Churchill 1966:1225).

Munawaba: Local Organization of Irrigation

Local irrigation groups known as munawaba are the backbone of irrigation at the local level. Munawaba groups are local structures formed to organize irrigators who share adjoining irrigation canals and water lifting devices. Land owners in each munawaba are allotted specific times during a two week cycle during which they may irrigate their land.

The current munawaba structures governing local water allocation and enforcement are directly descended from the irrigation management system developed during the British colonial period. Scott-Moncrieff devised a hierarchical system of British Irrigation Inspectors who became "the arbiters of Egypt's agricultural life" (Tignor 1966:115). These inspectors lived in the rural countryside among the peoples whose water rations they distributed and lives they organized. They controlled and enforced irrigation schedules, devised systems of water allotments, and adjudicated disputes when irrigation conflicts arose.

These colonial Irrigation Inspectors held at least as much irrigation authority as the contemporary munawaba chiefs do today (Tignor 1966:114-116; Willcocks 1913). There are of course significant differences between the British Irrigation Inspectors and today's munawaba chiefs, not the least of which is that munawaba groups and their leaders are local men rather than foreign-born colonialists. Though the munawaba leader does not have the absolute power of a colonialist Irrigation Inspector, there are clearly differential power relationship between the munawaba-leader and the other members of the irrigation group.

The amount of time each irrigator is allowed to irrigate is directly tied to the size of their land though there is no universal ratio used to calculate irrigation time throughout the Fayoum. The amount of time each plot of land is allowed is a proportional ratio of the amount of water available to the entire munawaba group. Because various amounts of water are available throughout the Fayoum, this ratio is also variable within each munawaba. As discussed above, the Ministry of Irrigation regulates the amount of water passing past each weir, and each weir is governed by different calibration ratios (i.e on some mesqas, 1 mm of water serves one feddan of land).

> Originally it was the calibration itself that was decided according to the level of water in the canal, and this level depended on the topography of the area. But now that the regulating structures have been built of concrete, the level has become the dependent variable. (Mehanna et al. 1984:96)

The amount of irrigation time which a piece of land is allotted is directly tied to the ownership (or rental) of land. This means that a parcel of land cannot be sold independently from its due irrigation water (though changes in the amount of land served--and types of crops served--can change the amount of water a plot receives). These changes are mediated indirectly by the state and directly by the local munawaba leader.

Irrigators in the Fayoum have developed methods to compensate distant farmers for their reduced shares of water. The feature known as magrur increases the amount of irrigation time proportional to the distance of a farmer's plot of land. The amount of extra time an irrigator is allowed is computed by floating a piece of straw or a stick from the water source (i.e. the point at which it leaves the main feeder-canal) to the destination field. The amount of time required for this straw to reach the field is then added on to the irrigators allotted time (Mehanna et al. 1984:103). Though this compensation method is not exact, magrur does take steps towards establishing a greater equity. As is discussed in the following chapter, irrigators have also developed a number of illegal techniques for increasing the amount of water they receive.

The amount of _magrur_ compensation allotted to an irrigator is recorded and added to an irrigators water-share by the _munawaba_'s leader; the _ra'is al munawaba_.

Each _munawaba_ group has a leader known as the _ra'is al-munawaba_, (henceforth simply referred to as "_ra'is_", literally, "chief" or "president"). The _ra'is_ can be called upon to mediate disputes, and can (attempt to) direct _munawaba_ members to engage in maintenance activities if there is some degree of consensus that such work is warranted. The _ra'is_ directs local labors such as weed control, canal cleaning and dredging.

There are strict schedules determining when any particular _munawaba_ member has the right to irrigate. These schedules are recorded and supervised by the system's _ra'is_. The _ra'is_ must own some land within the _munawab_ group he oversees. The position of _ra'is_ is an unpaid one, and is generally held by a wealthy individual from a well known, large landholding family. The title of _ra'is_ is passed at the discretion of each _ra'is_ and is frequently passed on from father to son. In many ways the _ra'is_ is a liaison between the village and the state.

At the local level, the _ra'is_ coordinates the use of water and keeps records of _mesqa_ schedules. When the Ministry of Irrigation alters the width of a given weir, it is the _ra'is_ who recalibrates individual water shares. When problems or conflicts require the presence of the Ministry of Irrigation it is the _ra'is_ who brokers such contacts. If the _ra'is_ is remiss in coordinating the _gafaf_ maintenance duties, engineers from the Ministry of Irrigation contact him and dictate what work must be completed.

The _ra'is_ keeps written records of each irrigator's allotted irrigation time. Like Mehanna, I did not find any of the _ra'is_ to be cooperative or friendly towards me (Mehanna et al 1984:116). They were instead very secretive about their records and seemed to resent any inquiries into their jurisdiction.

Within _munawaba_ groups there are (often) smaller sub-groups known as _tarafs_ which can combine and re-allocate the water of contiguous irrigators. _Tarafs_ function by combining the allotted irrigation time-shares into a single time-cluster which can be more finely manipulated and controlled than can water-shares at the _munawaba_ level. _Taraf_ irrigators still have rights to the same quantity of water, but they can trade their rights within the _taraf_ to fit their own schedules and the needs of the particular crops they are growing. This trading of time can be conducted without consulting other members of the _munawaba_ group.

The requirements of the crops each irrigator is growing is the crucial variable governing whether or not an irrigator will attempt to borrow or lend water. Any member of this _taraf_ is free to _try_ and borrow or lend any of his irrigation with other _taraf_ members, though some _taraf_ members have more control over this than others.

As described by Mehanna, the emics of the _taraf_ system are as follows: A weekly schedule is followed to determine when irrigators will be allowed water to flow from main canals into feeder canals, and when they can divert water into their fields.

> The ordering in the schedule is rather fixed, not only from year to year, but from generation to generation. So a farmer irrigates exactly when his father did. The most important _tarafs_ (status wise) start first, but this is a purely formal advantage, since water is continuously on. . . .The first people in the ordering have the privilege of deciding whether they will borrow time from their fellow _taraf_ members or not. They always give it back the week after. The weak member of the _taraf_ gets the left-overs, usually averaging to their fair share of water. (Mehanna et al. 1984:121)

Mehanna's assumption of the _taraf_ system's equity is questionable given what is known about the favored positions of up-canal irrigators in gravity-fed irrigation systems around the world. The research on canal irrigation societies and conveyance loss discussed in chapter three led me to question Mehanna's denial that an individual's position in the irrigation schedule was of any significance. With this broader understanding of gravity-fed irrigation there are a number of issues raised by Mehanna et al's conclusions.

To begin with, how "purely formal" an advantage is it to have the unilateral ability to borrow water from your neighbors? In times of scarcity this convenience can mean the difference between the success and failure of an irrigator's crops. In this case it would seem that "formality" is little more than a name given to the apparent order of social power.

If there are advantages derived from being a top-ended irrigator and the order of the irrigation schedule is inherited from one generation to the next, then it should be expected that these advantages would multiply through the passing of generations. This would be through the ability of top-ended irrigators to expand down-canal from their higher profit returns than their neighbors. The following chapter further examines the relationships between up-canal and down-canal irrigators and presents evidence suggesting there are advantages in being an up-canal irrigator.

A Dry Run Through the Irrigation Process

Most irrigators throughout the Fayoum go through the same general steps of irrigation. Irrigators reliant on pumps are not as tied to the same scheduling regimes as gravity or saqiya irrigators (see step 2). Beyond this difference, the general irrigation behavior is the same regardless of the water lifting device used. Fayoumi irrigators depending on gravity, saqiya and undershot waterwheels perform the following nine steps of irrigation: 1. Prepare the field; 2. Schedule; 3. Lift Water; 4. Clear Water-Way/Open Field; 5. Lookout; 6. Water Sections of Field; 7. Wait; 8; Stop Water Flow; 9; Wait; 10. Drainage.

There are some variations on these ten steps relating to the requirements of planting and specific crop care, but this is the general pattern followed through out the Fayoum. The basic stages of irrigation are as follows:

Preparation of the Field. Irrigators usually prepare the field for irrigating by subdividing the field with small dirt levies so that water can collect in one portion of the field at a time. Often irrigators will prepare their fields for the next time they irrigate at the end of their irrigating turn when the soil is wet and malleable. Farmers will roll up their gallebiyas and use short handled hoes and their hands to move and pack the soil of their plots.

Schedule. As discussed above, irrigators are subservient to a fixed irrigation schedule which dictates the exact hours they may irrigate their land. This schedule is unchanging and each irrigator receives water once every two weeks. Many farmers still use the traditional "arabic" twelve hour time system which begins with 12:00 at "sunrise" (i.e. 6:00 AM), and restarts at "sunset" (i.e. 6:00 PM).

Pump irrigators are tied to much more flexible schedules than gravity irrigators. Pump based groups still schedule pump access, but the pressures of keeping to an exact schedule are much less among pump irrigators. Often pump irrigators determine their irrigation time by coordinating their irrigation time with neighbors (on an ad hoc basis) who will use the rented or shared pump before and after them.

Lift Water. Farmers are responsible for seeing that water is lifted (if necessary) from the feeder canal to their field. This primarily applies to the use of the animal driven saqqiya, farmers using gravity fed canals or the undershot waterwheel do not need to further lift the water. It is the irrigator's responsibility to both provide the traction animal used to drive the saqqiya and to see to it that the wheel keeps moving. Often children remain at the site of the saqqiya to encourage the animal to keep driving the wheel.

Clear Water-Way & Open Field. Irrigators are responsible for keeping clear the feeder-canal path between the main canal and their fields. This means that if the ridges surround these small ditches collapse they must repair such points of spillage. They also must open and monitor small diversionary dams to channel water into their desired fields.

There are a number of different objects which farmers leave at canal junctions and use to block the flow of water from one canal to another, or from a canal to their fields. The most common method of blocking or diverting canal water flow is a simple mud dam. It is primarily used along the smaller fields directly bringing water to the fields. Mud is simply packed along the opening to a field or canal with a widening base at the bottom and a smaller amount of mud at the top. Sometimes a farmer will take care and mold the dam into a symmetrical, sturdy dam, at other times the dams are made very haphazardly allowing for water to flow or seep past.

There are also cement and metal water gates. These gates are located along moderate sized conveyance canals. Cement bulks are set into both sides of the banks with a wide opening (30-100 cm) spanning between the bulks. A metal (sometimes wooden) plank/gate can be inserted (lowered or raised) in a slot between the two bulks to regulate the flow.

Stone and brick bulks are also used to control water flow into a field. Long portions of stone and brick are often left at canal junctions by farmers who use them repetitively to block the flow of water from a main canal. In the fields around Keyman Faris I have seen a number of artifacts from the Roman period used for this. The farmers see this as one of the few positive aspects of all the scattered artifactual remains.

Keeping a Vigilant Lookout. An additional component of this is the need of irrigators to be on the lookout for water theft while irrigating. As noted by Mehanna et al.,

> Everyone gets his fair share of water (more or less), but at the cost of watching not to be cheated, which means that when someone is irrigating, someone else

> must stay at the branching point on the canal to make sure nobody comes and diverts the water. (Mehanna et al. 1984:109)

All irrigators keep someone near the canal and fields while receiving water. At times it is only a child, and at others a number of adults will continuously walk the path of the water from the _saqiya_ to the field.

Again, this step applies much less to the pump groups who are not as rigidly locked into their irrigation schedules.

Irrigate sections of fields. Once water arrives at the land the irrigator usually waters different portions of the field with the aid of small ridges and levies segmenting the land. Depending on the crop, the irrigator will usually open other sections of land to be irrigated after some time passes. Irrigators either tie their _gallabeiya_ up above their waiste, or simply wade around in underwear and t-shirts as they fine-tune the distribution of water within their fields.

Wait. Irrigators are only allowed to irrigated for the predetermined scheduled period of time which is proportionate to the size of their land. After irrigators have diverted water to the fields there is usually some period of waiting until their time-share is completed. Irrigators usually find some nearby shade and wait for their time to expire (on more than one occasion I observed just such "napping" irrigators experiencing the rude-awakening of a tantrum being thrown by the next scheduled irrigator whose precious time has been infringed on by a sleeping irrigator). If the irrigation period is greater than a few hours, irrigators will generally assign a young family member to stay near the field and make sure that the water keeps flowing.

Stop Water Flow. When the irrigator's scheduled time has expired they must close off the opening where their field joins the canal. This is done by simply re-damming the canal's entrance to their field.

Irrigators must also turn over the control of the water-lifting device to the next scheduled irrigator. If the irrigator is using a saqiya, the animal driving the wheel is unharnaced and the next scheduled farmer can being irrigating.

Wait. Irrigators let water stand on their fields (for different time lengths for various crops) before draining off the water.

Drain Off Standing Water to Drain. The final irrigation activity is drainage. Irrigators drain their fields by creating an opening in dirt at the edge of their fields near the drainage ditch.

These ten steps are carried out most usually by farmers and their families, they do not require the assistance or regulation of either the local munawaba group or the state's Ministry of Irrigation. To the fellaheen, the local and state structures only become involved in such daily activities when there are problems. Though most Fayoumi irrigators can irrigate their fields and go about their daily business without confronting agents of the state, it is a mistake to loose sight of state's role in supporting all infrastructure sustaining all these activities.

Summary and Conclusions

Far beyond the bureaucratic organization and demands of the state's Ministry of Irrigation is the day-to-day irrigation of Fayoumi fellaheen. On most days, Fayoumi irrigators do not come into direct contact with the Ministry of Irrigation or other agents of the state bureaucracy--though often the fellaheen do spend time avoiding these agents of the state as we will see in the next chapter. The organization which most fellaheen come in contact with is the local munawaba group which regulates some of their actions. At the Fayoum's local/village level, the munawaba group is the focus of irrigation organization. The general organization of local irrigation is established by the Ministry of Irrigation, though munawaba groups usually function on their own with a minimum of government interference.

The importance of munawaba groups and the state's lack of local Ministerial institutions overseeing all aspects of the daily allocation of water has led some analysts to conclude that Fayoumi irrigation is primarily locally administered (Mehanna et al 1984:134). Still, these same analysts must admit that for all of Egypt,

> The Faiyum gravity flow system has the most complex and the largest-scale organization. It is typical that it is only in Faiyum that village officials are involved in the social organization of irrigation. (Mehanna et al. 1984:135)

The local importance of the munawaba group does not discount the state's vital role in Fayoumi irrigation. The local organization of irrigation does not preclude the state's vital role in delivering water to the local level. As is discussed in chapter thirteen, the state's decision to govern irrigation only until water passes the last weir serves the interests of the state to a higher degree than a stronger local presence would.

The technologies of pumps, undershot waterwheels, gravity and saqiya are used to lift water to field levels throughout the Fayoum. Except for the internal combustion pumps, each of these water lifting technologies have been used in the Fayoum for millennium. Though the basic organization of munawaba groups is similar throughout the Fayoum, we will see in the next chapter that these different water lifting technologies led to different munawaba dynamics. Before the issue of the state's role in the Fayoum is further examined, the following chapter addresses issues of conveyance-loss and water theft in the Fayoum .

Notes

1. I arrived in Egypt in Early July 1989, but spent a few weeks up in Luxor excavating in the Valley of the Kings with Mark Papworth and Donald Ryan, as well as some time doing research in Cairo.

2. See Toth (1991) for a general discussion of the gender division of labor in rural Egypt.

3. There are currently efforts by the New Democratic Party (NDP, Mubarak's party) to more than double the legal rates charged for land rentals as a means of increasing the governmental tax base (for discussion see Springborg 1991).

4. Programs through western agencies such as the U.S.A.I.D. require participant countries to use U.S. durable goods in their projects. This in effect rechannels project monies directly back to the U.S., and virtually assures a long-term business relationship with the U.S. through the future needs of replacement parts.

5. Once, when talking to a young man, Khaled, who was the youngest of twelve, I asked him about the size of family he planned to have. He replied that he will have one of at least the same size, that there were blessings to be found numbers. When I asked him if some of Egypt's current economic problems might be due to the strains of overpopulation he answered that though his own family was poor (which it surely was) no one in his family had ever gone to bed hungry. He admitted that they seldom ate meat, but there were always bread and beans at his house. Khaled was in his mid twenties and still single, largely due to the expense of bridewealth. It may be true that being from a large poor family he never went to bed hungry, but it is certainly not true that this same setting hadn't caused him to go to bed alone (much to his frequently voiced chagrin).

6. The Tunbur (Archimedes screw) is also sometimes used to supplement water delivery (and theft) though I know of no instance where the tunbur is used as the primary means of lifting water in the Fayoum.

7. I requested this and other records from the ministry on many different occasions, and more than once I was told I could see such records, but in the end I did not receive records documenting the distribution of lifting devices. (not exactly clear if this was just normal bureaucratic procrastination, or if the records didn't exist).

8. The gamousa (water buffalo) is the most common traction animal used in the Fayoum.

9. They may have more than four wheels at a given spot, but I have never seen more than four wheels in one spot.

10. There are some undershot wheels that are over three meters in diameters, though these are less common.

11. The Archimedes screw takes its name from the belief that Archimedes designed the first screw of this type in Alexandria.

12. The area of Keman Faris in the last century had a number of antiquity shops, in mid century the mound was gigantic.

> When Lepsius visited Kom Faris in 1843 the mound there rose to a height of 82 feet, towering over Crocodilopolis; it was at one time the most extensive ruin of a town in Egypt, covering an area of about 558 acres. (Kees 1961:229)

13. Countless archaeological sites in Egypt have been lost due to the activities of Fellaheen digging for <u>sebbakh</u>-supplements for their soils. Of course numerous papyrus discoveries were made due to this activity.

14. The fellahin are split between two explanations for the presence of these fragments. Some say they are from the time of the Pharaohs, others say they are modern pots broken in transit. But all agree that these shards are a hinderance to good farming. When farmers plow, plant, or weed these lands, they constantly toss shards out of their plots of land, either into the surrounding irrigation ditches, or onto unattended neighboring fields. I never saw a farmer toss shards onto an adjoining field while the neighboring farmer was anywhere in sight. The humor of all this is that, on a number of different occasions, I observed farmers tossing shards into fields whose owners I had previously seen toss shards into their fields.

15. Qasr al-Basl literally translates as "Palace of Onions".

16. Many of the villages that border the desert have lineages that are locally identified as being bedu. These lineages for the most part are today sedentary farmers though some families still subsist through grazing sheep, goat and camels and engage in smuggling activities along desert routes (usually using trucks). These "bedu" were most peripheral to my irrigation research but their presence deserves some comment. Among Fayoumi villagers the Bedu are considered to be the "true" arabs. They are spoken of as having honor and as being remnants of a more noble past.

They are also paradoxically spoken of as being both cunning and simpletons. The Basil family's tribal origins "stemmed from [a] notable bedouin [tribe] which threatened Upper Egypt at frequent intervals during the first half of the nineteenth century" (Davis 1983:38). During the late nineteenth century Basil family members purchased large blocks of land in Upper Egypt (near al-Minya) and at different areas of the Fayoum, though primarily in the southern and western regions of the Fayoum, e.g. Qalamsha, Totun, Qasr al-Basl, (Davis 1983:38,61,161).

17. Marijuana and opium poppies are the most lucrative crops grown in the Fayoum, but their illegal status and association with organized crime (with government protection) made it both dangerous and difficult to study. A few episodes of happenstance though, revealed that some degree of the region's illegal drug growing occurs in this central orchard region of the Fayoum. Many farmers grow small amounts of marijuana for their own personal use.

CHAPTER 12
WATER THEFT AND CONVEYANCE LOSS IN THE FAYOUM.

> Fallahin throughout the ages have invented thousands of tricks to mitigate the rigours of their exploitation.
> ---Afaf Lutfi al-Sayyid Marsot

A Look at Conveyance Loss to Exemplify the Limitations of a Centralized State's Power

As discussed in the third chapter, all societies reliant on gravity fed irrigation experience some degree of conveyance loss. The Fayoum's hydraulic history demonstrated how conveyance loss influenced which villages could survive periods of state neglect, and showed an overall hydraulic pattern favoring up-canal irrigators. In the setting of the present day Fayoum, conveyance loss effects an individual's economic development, but it also illustrates the limits of the Egyptian state's power over irrigation matters.

Conveyance Loss and The Importance of Scheduling Ernest

In describing the irrigation weir systems of the Fayoum el-Quosy noted that,

> This kind of system guarantees [sic] fair distribution of water between farmers but on the other hand it is too sensitive to derivations. This means that <u>if the farmers in the Upper part of the canals managed to get more than their fare share, then farmers at the tail ends are going to suffer from shortage of water</u>. (el-Quosy 1981:14 et al. emphasis added)

This is a profound insight into the general assumption of equality that is at the base of the Fayoum's water distribution system. The ability of farmers at the front (or "top-end") of the system to receive more water than distant farmers is a design flaw in the Fayoum's irrigation system. Below we will examine some of the implications and consequences of this "up-canal" advantage.

Fayoumi farmers recognize some degree of inter-canal water loss, and magrur compensations are used to try and rectify these inequities. Magrur is a step towards greater equality in access to water, but it does not necessarily create equality. Mehanna does not mention any farmer perceiving the system of magrur compensation as being anything other than a fair and just system of recompense for a natural loss. But the evidence from such irrigation systems used by other cultures suggests that "being at the tail end of an irrigation system is often synonymous with being relatively powerless in irrigation matters" (Bromley et al. 1980:366). This raises questions about whether or not magrur adequately compensates irrigators for the quantity of water lost in transit.

Beyond raw economic calculations, little is known about the social consequences of conveyance loss on the formation of cultures. The little social research on conveyance loss that does exist has concentrated on its economic and agricultural effects. Given the known pattern between infrastructure and social structure there are obvious reasons to assume agricultural and economic aspects of society effect a culture's social structure, but this effect has not been studied as a secondary effect of conveyance loss.

The economic effects of conveyance loss are well known for Egypt. In fact conveyance loss accounts for almost half of the water consumed in all of Egypt. In the mid 1970s the USAID calculated that the combination of on farm water loss and conveyance loss accounted for over 45% of Egypt's real water needs (Waterbury 1979:219). There is no reason to believe that this situation has changed in the last decade and a half. If nothing else this waste of water has the social effect of placing Egypt's national security in jeopardy--given the sentiment expressed by Presidents Anwar Sadat and Hosni Mubarak that Egypt's next major war will be fought over water rights with its upstream neighbors (New York Times Feb. 7, 1990:A4:3).

I measured conveyance loss in canals to determine at what level it was occurring, and to see if there was any correlation between such loss and the economic and social order in the Fayoum. I commissioned a blacksmith to construct a portable RCB flowmeter out of sheet metal. This single water meter was used for all measurements in my study. The quality of workmanship of the weir's construction was high, but there is the possibility that its dimensions were not exact.[1] Any error in the weir's design could effect the external validity of my data, but would have no bearing on it's internal validity. This is to say that, if I measured (for example) an extra three liters per hundred due to construction error, this error would be perpetuated in every measurement, and not effect the internal integrity of the data (see Bernard 1988:65-67).

The design of the gauge is simple (see Bos et al. 1984 for blueprints and a description of the RCB flow gauge). It is little more than a portable flume: its shape is that of a small trough which is placed directly into a feeder canal. Baffles at one end divert the whole of the canal's flow into the gauge. At the down-flow end of the gauge a small ramp interrupts the flow, causing the water surface to dip at the far end of the ramp. As described by Bernnulli's law, the water after the ramp will dip at increasing levels in direct proportion to the rate of flow. Because the flume's volume is a controlled constant, differences in the speed of water flow may be directly calculated as differences in flow. Water level measurements are taken at a point where the water enters the weir and at its low point after it encounters the ramp. The differences between these two points are calculated and the liters per minute rate can be determined.

I measured water flow rates and conveyance loss rates of irrigation groups from the five village areas described in the preceding chapter. The portable flow gage allowed me to measure the amount of water lost in transit to fields, and to see if the compensatory features of magrur were sufficient to offset this loss to irrigators.[2] This was the first step necessary for determining if social methods of compensation were adequate to off-set the inherent inequalities of the gravity fed irrigation system.

My initial measurements indicated that conveyance loss was a significant phenomena in all five of the irrigation communities I studied. Figure 12-1 and Table 12-2 illustrates the degree of water loss in terms of field ranking at the different field sites throughout the Fayoum. There is a clear pattern of reduced water reception the further an individual plot is from a water source. This diagram does not figure the additional quantities of water received through magrur compensation.

Other measurements indicated that magrur compensations do not completely re-imburse down-canal irrigators for the effects of conveyance loss. Figure 12-2 (data in table 12-2) illustrates conveyance loss' relation to a field's ranking of distance from these same field sites with the compensatory magrur added to the calculation. This data illustrates that magrur is an insufficient measure to compensate farmers for the amount of water lost in transit.

TABLE 12-1

DESIGNATION	LOCATION	WATER LIFTING TECHNOLOGY USED
Ke1	Keman Feris One	Undershot Waterwheel
Ke2	Keman Feris Two	Undershot Waterwheel
Naq1	Naqalifa One	Undershot Waterwheel
Naq2	Naqalifa Two	Undershot Waterwheel
Q1	Qasr al-Basl One	Pump
Q2	Qasr al-Basl Two	Pump
Q3	Qasr al-Basl Three	Pump
Shak	Shakshouk	Saqiya
San1	Sanhour One	Saqiya
San2	Sanhour Two	Gravity Alone

TABLE 12-1 Listing of irrigation groups, name designations used in figures and tables, and primary technologies used in water lifting.

The technology of water delivery in the Fayoum is crude and as such almost necessitates inequities of distribution. The unlined canals permit ground seepage of water at all points of its journey from the Nile to the Ibrahimia Canal to Bahr Yusuf and into the Fayoum. These measurements of water loss show that the institution of Magrur is clearly insufficient to compensate irrigators for the amount of water lost in transit.

Position, Power and Conveyance Loss

I interviewed farmers in different irrigation groups about perceived positions of power and social standing for themselves and their fellow irrigators. I used these interviews as a supplement to participant observation techniques in order to gather information on individual's perceived social position in their communities; general knowledge about irrigation, agriculture and land tenure

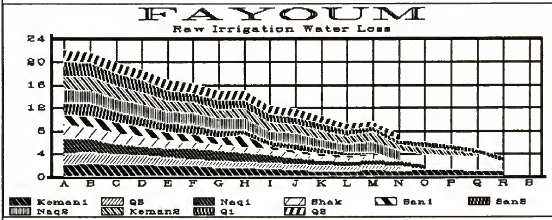

Figure 12-1 Raw Liters Per Second (without Magrur compensation) water rates in ten Fayoumi irrigation groups.

issues. I adopted David Freeman's field methodology for measuring the power distribution within irrigation networks and added to it the dimension of field location (see Freeman 1982). Freeman asked Pakistani farmers to rate how much power specific irrigators had in "matters of mobilizing other farmers to clear and maintain the commonly held water channels" (Freeman 1982:71).

Like Freeman I allowed for five possible answers ranging from "no power" to "much power", but unlike Freeman

TABLE 12-2

H20 Rank	Ke1 Raw Magrur	Ke2 Raw Magrur	Naq1 Raw Magrur	Naq2 Raw Magrur
01	1.9 = 1.9	2.3 = 2.3	2.5 = 2.5	2.4 = 2.4
02	2.2 = 2.2	2.3 = 2.3	2.3 = 2.3	2.3 = 2.3
03	1.9 = 1.9	2.2 = 2.2	2.0 = 2.0	2.2 = 2.2
04	1.9 = 1.9	2.0 = 2.0	1.8 = 1.9	2.0 = 2.0
05	1.8 = 1.8	1.9 = 1.9	1.7 < 2.2	MD
06	1.7 < 1.8	1.8 < 2.0	2.0 = 2.0	1.7 < 2.0
07	1.5 < 1.7	1.6 < 1.9	1.9 < 2.0	1.6 < 1.9
08	1.4 < 1.8	1.7 < 1.9	1.6 < 1.8	MD
09	1.2 < 1.5	1.5 < 1.9	1.5 < 1.7	1.8 < 1.9
10	1.0 < 1.7	1.5 < 1.8	MD	1.6 (1.7
11	0.9 < 1.6	1.5 < 1.9	1.0 < 1.8	1.5 < 1.7
12	0.9 < 1.7	1.6 < 1.8	1.2 < 1.5	1.3 < 1.5
13	1.0 < 1.5	1.5 < 1.7	1.1 < 1.7	1.2 < 1.7
14	MD	1.4 < 1.7	1.5 < 1.7	1.0 < 1.5
15	1.1 < 1.6	1.5 < 1.8	1.7 < 1.9	MD
16	1.2 < 1.7	1.5 < 2.0	1.0 < 1.8	1.2 < 1.5
17	0.9 < 1.5	1.2 < 1.9	MD	1.3 < 1.6
18	MD		MD	
19	1.0 < 1.4		MD	
20			1.5 < 1.8	
21			1.3 < 1.7	
22			MD	
23			1.0 < 1.7	
24			1.2 < 1.9	
25			0.9 < 1.8	
26			1.0 < 1.6	

H20 Rank	Shak Raw Magrur	San2 Raw Magrur	San1 Raw Magrur
01	1.9 = 1.9	2.0 = 2.0	2.3 = 2.3
02	1.9 = 1.9	2.2 = 2.2	2.0 = 2.0
03	1.8 = 1.8	1.9 = 1.9	1.8 = 1.8
04	1.6 < 1.8	1.8 < 1.9	1.6 < 1.9
05	1.4 < 1.8	1.5 < 2.0	MD
06	MD	1.7 < 1.8	1.3 < 2.0
07	1.1 < 1.8	1.3 < 1.8	1.1 < 1.9
08	0.9 < 1.7	1.1 < 1.6	1.0 < 1.8
09	0.6 < 1.4	1.0 < 1.8	MD
10	MD	1.2 < 1.7	0.8 < 1.7
11	0.6 < 1.6	0.8 < 1.5	0.6 < 1.7
12	0.5 < 1.7	0.6 < 1.2	0.5 < 1.8
13	0.5 < 1.5	0.5 < 1.5	0.5 < 1.8

TABLE 12-2 Water Delivery Rates (LPS) Before (Raw) And After Magrur Compensation. The "H20 Rank" column refers to the order in which water is received in the irrigation system. Pump groups are excluded. MD signifies missing data. Many measurements taken at point where water passed field while not irrigating.

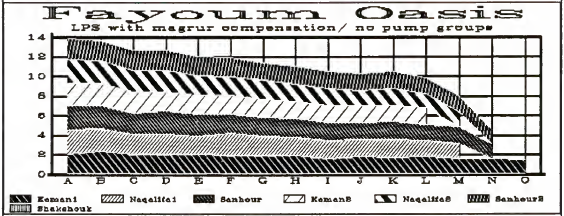

Figure 12-2 Waterloss in seven (non-pump) groups with magrur compensation added. This illustrates that magrur compensation efforts still result in reduced water delivery for downstream irrigators. Note that pump groups are not shown in figure 12-2 because they do not use magrur compensations.

I correlated answers not with the irrigator's adoption of agricultural innovations but with their rank distance from the main water source. Freeman did not attempt to correlate the information from his interviews with particular irrigator's upstream/downstream positions in their irrigation network.

Informants were asked to rank their own ability, and the abilities of each of the individual irrigators within their irrigation network to get other irrigators to engage in canal maintenance work. Specifically they were asked if they had; "no power", "a little power," "some power," "moderate power" or "much power." Informants were asked about the specific power rankings of themselves, and their co-irrigators in a random order (so as to disassociate the results from any tendency of informants to rank their answers in some order related to the ordering of questions). Each of these five possible answers was assigned a numeric value ranging from 0 to 4 ("no power" = 0, "much power" = 4). After interviewing each individual member of an irrigation group, I added each of the "power" scores an individual received from the aggregate irrigation group. This allowed me examine both individual's perception of their own "power", and (it turned out more importantly), the cohesive-composite view that the whole group had of itself.

This questionnaire was administered to groups reliant on each of the four methods of water lifting (gravity, saqqiya, undershot water wheel, pump). Later I reclassified and merged these four groups into two groups: those using pumps and those not using pumps. The aggregate data pertaining to all irrigators was then analyzed using the irrigators' upstream/downstream position as the independent variable. This produced two remarkably different patterns of responses: patterns that revealed power relationships determined by individuals' upstream/downstream location in the system.

I was initially surprised at the pattern found in the Naqalifal community. I had expected that the most distant farmers--who had the most to lose with poorly maintained canals--would have developed methods by which they could coerce other farmers to upkeep the canals at times of disrepair. This turned out to be an optimistic expectation.

The results of questions on irrigator's ability to mobilize other irrigators for maintenance work show two different response patterns that correspond to the type of technology used to deliver irrigation water. The data from communities reliant on internal-combustion pumps shows no correlation between an individual's "power" rating and their geographical position within the irrigation network. The data from the groups using the traditional saqqiya indicate a correlation between "power" and a farmer's location relative to the main irrigation canal.

Figure 12-3 demonstrates the greatest differences in the patterns of responses. These two groupings also had the most different types of water delivery technologies. The three pump group communities from Qasr al-Basl are represented in figure 12-3, as noted above these groups are completely reliant on internal-combustion pumps to raise the irrigation water from the main canals to field levels. The

Table 12-3

Irrigation Group
And Freeman Power Score

H20 Rank	Ke1	Naq1	Naq2	Ke2	Q1	Q2	Q3	Shak	San1	San2
	U	U	U	U	P	P	P	S	S	G
01	58	58	42	39	35	46	37	49	47	39
02	50	49	55	47	21	31	39	44	39	28
03	44	55	52	44	27	28	29	52	37	42
04	40	60	46	51	22	42	40	38	55	48
05	44	44	62	43	31	27	33	40	28	43
06	52	40	58	17	21	36	38	43	45	44
07	38	47	52	40	18	17	27	32	49	39
08	66	50	57	42	24	46	26	37	26	43
09	47	38	48	36	14	42	36	25	34	44
10	61	45	49	37	28	24	22	29	39	37
11	48	37	26	29	40	28	29	31	25	39
12	37	37	53	38	17	49	38	27	21	33
13	28	32	47	19	32	20	24	29	23	27
14	21	29	39	27	27	26	27			
15	39	33	35	31	24					
16	15	28	43	26	27					
17	44	30	37	22	33					
18	27		33		28					
19	18		25		14					
20			41		32					
21			28							
22			37							
23			19							
24			34							
25			18							
26			23							

U = Undershot Waterwheel   P = Pump   S = Saqiya   G = Gravity

Table 12-3 lists the scores of irrigators from the Freeman power question listed in irrigation order. Symbols at the top of the table indicate the name of the irrigation group and the type of water-lifting technology used.

Table 12-4

Freeman Power Score
Expressed as Percent of Possible Score, By Group.

	Ke1	Naq1	Naq2	Ke2	Q1	Q2	Q3	Shak	San1	San2
	U	U	U	U	P	P	P	S	S	G
H20 Rank 01	76	85	40	57	44	82	66	94	90	75
02	65	72	52	69	26	55	70	84	75	54
03	57	80	50	65	34	50	52	100	31	81
04	52	88	44	75	28	75	71	73	67	92
05	57	65	60	63	39	48	59	77	54	83
06	68	58	55	25	26	64	68	83	86	84
07	50	69	50	59	22	30	48	62	94	75
08	86	73	55	62	30	82	46	71	50	83
09	61	55	46	53	18	75	64	48	65	84
10	80	66	47	54	35	43	39	56	75	71
11	63	54	25	43	50	50	52	60	48	75
12	48	54	51	56	21	88	67	52	40	52
13	36	47	45	28	40	36	43	56	44	52
14	27	42	38	40	34	46	48			
15	51	49	34	46	30					
16	19	41	41	38	34					
17	57	41	36	32	41					
18	35		32		35					
19	23		24		18					
20			39		40					
21			27							
22			36							
23			18							
24			33							
25			17							
26			22							

U = Undershot Waterwheel   P = Pump   S = Saqiya   G = Gravity

Table 12-4 lists the scores of irrigators as percentage of possible points from Freeman power question (listed in irrigation order). Symbols at the top of the table indicate the name of the irrigation group and the type of water-lifting technology used.

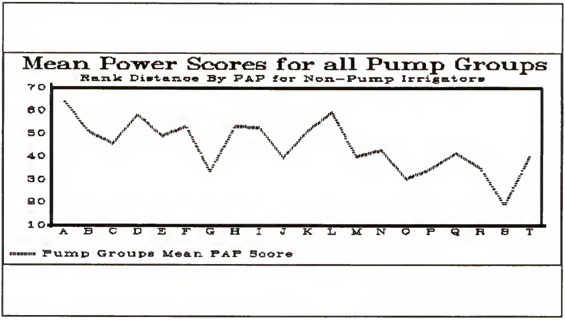

Figure 12-3

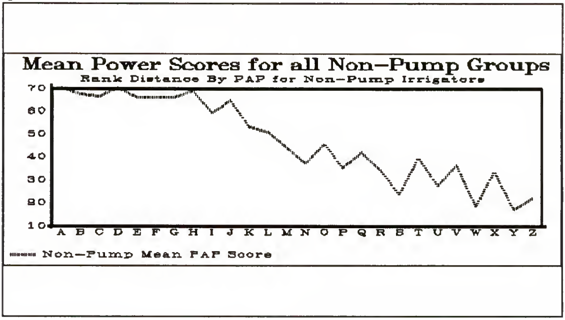

Figure 12-4

Figures 12-3 and 12-4 illustrate the differences in the perceived power to mobilize other irrigators for maintenance activities in pump and waterwheel groups. Individual irrigators in both groups are arranged in order of distance from water sources.

second graph (Figure 12-4) represents the combined gravity irrigation groups. These two patterns indicate a profound influence of technology on social relations. The up-canal/down-canal pattern is all but gone in the composite pump group.

One conclusion to be drawn from these two patterns is that technological efficiency destroys an irrigation community's dependency on cooperation.[3] Among undershot water wheel groups there is a collective perception that "top-end" irrigators' have relatively greater "power" over those below them in their irrigation network. The pattern of these scores indicates a recognition by irrigators' that the "higher" irrigators are in the rank canal ordering, the greater their "power" over the irrigators below them. There are other possible interpretations of this distance related response pattern. That bottom-end irrigators are perceived as less powerful in initializing cleaning could also be indicative of a general pattern of maintenance procrastination where distant irrigators are the first effected, and thus the first to complain about run-down canals. By the time the "top-end" irrigators are personally affected by canal dilapidation to the point of complaining everyone else is fed-up to the point of taking action. When those at the front complain, things must be in pretty bad shape.

TABLE 12-5

Crosstabulation: Power-Test Score Collapsed into 3 Categories by Liters per Second Collapsed into 3 Categories

LPS-> POWER	Count	.4-1.0 LPS	1.1-1.7 LPS	1.8-2.5 LPS	Row Total
	LOW	18	9	2	29
	MEDIUM	12	16	7	35
	HIGH	7	12	35	54
	Column Total	37 31.4	37 31.4	44 37.3	118 100.0

Statistic	Value	Significance
Gamma	.68826	

TABLE 12-5 <u>Gamma computation</u>. Bivariate table Showing crosstabulation between Liters per Second and the results of the compressed "power-test" score of <u>all sampled gravity based irrigation groups</u> (pump groups excluded). The 3 "power-test" and LPS groups were established by dividing the result frequencies into equal (cum percent) groups. Power group 1 = scores 15-34 (.8%-33.1%), Power groups 2 = scores 35-45 (33.9%-66.1%), Power group 3 = scores 46-66 (66.9%-100%). LPS group 1 = .3-1.0 (.8%-31.4%), LPS group 2 = 1.1-1.7 (36.4%-68.6), LPS group 3 = 1.8-2.5 (74.6%-100%).

Table 12-6 Pearon's r power scores and lps relationships

Device = Gravity Alone	POWER	LPS
POWER	1.0	.5070 (13) P=.077
LPS	.5070 (13) P=.077	1.0

Device = Pump	POWER	LPS
POWER	1.0	.2263
LPS	.2263 (48) P=.122	1.0

Device = Undershot Wheel	POWER	LPS
POWER	1.0	.5464 (79)
LPS	.5464 (79) P=.0	1.0

Device = Saqiya	POWER	LPS
POWER	1.0	.5593 (26) P=.003
LPS	.5593 (26) P=.003	1.0

Table 12-6 Pearson's r Test. Pearson's r test demonstrates the a strong positive linear relationship between non-pump irrigators closeness to a water source and their power within the irrigation system.

There are different implications for groups using pumps for water lifting. The use of pumps in irrigation diminishes the maintenance concerns of "bottom-end" farmers. The technology of water delivery allows distant irrigators to use extra irrigation time to make up for their inequities that may arise from poor maintenance. A position of perceived power in the pump irrigation groups was that of the actual pump owner. The pump owners received the high power ratings among their irrigation groups, no doubt because of their personal control over this aspect of the means of production.

In one sense, the technology of pumps can be viewed as an economic equalizer, though this is certainly a short sighted view. Given Egypt's dual problems of water shortages and the waterlogging of soils, the decreases in maintenance concerns that accompany the introduction of pumps are best thought of as a signpost of irresponsibility. Pumps allow irrigators to distance themselves from acknowledging the destruction and deterioration of the ecosystem they are emersed in.

It must be noted that this data on the perceived mobilization of power is emic, and not etic data. As such, these data do not represent behavior as much as they do cultural perceptions of behavior. Power here is expressed rather in "deference behavior" to he-with-the-pump. Though at no time did I observe any actions or proddings for action that contradicted the trends indicated in my "mobilization of power" survey. In terms of the actual mobilizations of canal maintenance that I observed and saw the after-effects of, there was a slightly greater proportion of "top-end" irrigators instigating such actions.

Water Theft: Emics, Etics & the Illegal

In the Fayoum, water theft is a vital cultural element of agricultural production (it is from such relationships that the english word "rival" derives from the latin rivalis: one sharing the same brook as another). Though illegal, water theft is the primary means for irrigators to increase their access to irrigation water. It can mean the difference between the success and failure of a crop, especially during the hydraulically crucial early years of an orchard's life. Water theft regularly occurs despite the fact that the emic/mental rules of Fayoumi irrigation are clear to all irrigators who participate in the drawing of water for their fields, and it is easy for anthropologists to elicit these rules from farmers. Mehanna quotes one farmer as saying, "How could anyone take water, water is my blood," but she did not take the next step of observing the frequency at which such instances of "blood letting" occurs (Mehanna et al 1984:109).

There is a relationship between the degree of conveyance loss and the practice of water theft. I recorded a total of 25 instances of water theft. Though it was not possible to record anything approaching the absolute frequencies of water theft, the instances of theft that I did record were all located at the back halves of irrigation networks rather than the front halves. The observation that water theft is an economic act is far from startling or new, but the recording of the thieves' rank position demonstrates material rather than moral reasons for such behavior.

One emic/mental cultural rule in the Fayoum is that people who steal water are of a low moral order. I found a correlation between the general social standing of a particular person and the proximity of their land holding to the main feeder irrigation canal. These people are also able to exert a greater control over the types of crops they grow and thus are more apt to plant orchards or other high return crops which demand abundant amounts of water. Individuals who lived closest to feeder canals were more likely to be able to afford the pilgrimage to Mecca in their later years--an action which greatly enhances their social and moral stance in the community. I was struck by how this arrangement also corresponded to individuals' distances from water sources--suggesting that those persons of a "higher moral order" had fields nearer to the main canals and would thus have less of a need to appropriate water.

The widespread practices of Fayoumi water theft illustrate some of the problems associated with anthropological inquiries which focus more on cultural rules than cultural behavior. Mehanna et al. recognized the practice of water theft in the Fayoum and discussed the possible penalties for those caught stealing water but there is no discussion of the impact of theft on the overall system. In my own fieldwork, I found that the prevalence of water theft negated many rules governing the distribution of water. Mehanna's focus on the rules of the Egyptian government obscures the actual behavior of individual and groups of irrigators.

Adams observed elsewhere in Egypt that despite the abilities of rich farmers to use their power to influence governmental authorities there is still,

> one important way in which rich farmers and poor peasants have joined together to evade government controls. In this particular area--water use--widespread farmer evasion of government controls has not disadvantaged any particular socioeconomic group. (Richard Adams 1986:93)

For the Fayoum I cannot agree with this statement. My measurements of water loss in the Fayoum indicate that poorer farmers tend to be located at greater distances from source canals than do more wealthy farmers. Despite the ability of both rich and poor farmers (near and distant from source) to attempt to evade governmental irrigation controls, farmers located closer to water sources clearly have less of a need to engage in this risky activity.

Though I found a higher occurrence of water theft as rank distance from source canals increased, there were few individual farmers who believed that the magrur compensation was not basically sufficient to make up for the amount of water lost in transit. Out of 120 irrigators questioned, only 10 responded that magrur was an insufficient means of compensating for water loss. Farmers as a whole believe that magrur is an adequate means of compensating distant irrigators, but my measurements of the inadequacies of magrur show this just isn't so. There is a universal impression of constant water shortages (n= 120 out of 120) among irrigators surveyed. There is an impression that this effects all irrigators equally. When irrigators'(as a group) fail to blame the abilities of magrur compensation for lost water, they are not proclaiming "all is well." They are instead indicating that their perceived realm of blame occurs at a supra-local level.

The institution of magrur is a step in the direction of equal access to water, but functionally it does more to instill a feeling of justice (or equality) among irrigation members than it does to rectify the inherent inequality of water delivery. It would be a mistake to underestimate the value of instilling such feelings of justice. Such symbolic representations of "good intent" go a long ways toward diminishing ill feelings toward up-canal neighbors and the state itself. Because magrur does not adequately compensate distant irrigators, they often turn to methods outside of the law to increase their water-shares.

There are costs and benefits for individuals engaged in water theft. Costs are incurred in the form of risks. The primary risk being the risk of detection, and then suffering either social or punitive costs for the theft. The benefits are clearly associated with the assumption that increased water will lead to increased crop health and production.

There are questions to be raised concerning the ethics of studying illegal activities, and the practice of not fully revealing to informants what aspects of their life are being studied. At no point did I lie to any informants. I told all of my informants that I was interested in studying a variety of aspects governing irrigation and agricultural techniques in the Fayoum. I never told an informant that I was monitoring while he engaged in water theft that I was studying this specific aspect of their behavior. To have done so would have been to alter the very behavior I wished to study.

There is every reason to expect that individuals involved in illegal activities do not wish their actions to be scrutinized by someone studying them. This is an aspect of cultural life which an exclusively emic approach has difficulty in coming to terms with. Illegal and unsanctioned actions generally have some sort of repercussions (social or punitive) when they are detected. With such contingencies individuals will alter behavior and make statements which will minimize the likelihood of their detection by the anthropologist studying them, thus underscoring the importance of distinguishing between emic and etic information sources.

In the Fayoum, water theft is emically rare but etically commonplace. Farmers often complain that they don't receive enough water for their crops because cultivators "up canal" are taking more than their share of water. In fact, one of the first farmers I could get to talk about his own water theft activities cited this problem as the justification of his illegal actions.

As with any illegal activity, studying the practice of water theft presented a number of fieldwork problems. Informants for the most part were unwilling to admit to being water-thieves themselves, though most were adamant in insisting they themselves were constantly being stolen from.

The epistemological concepts of emics, etic, mental and behavioral helped untangle the varieties of information I had. These concepts allow discussions without getting mired down in questions of intent, lying, or the consciousness of an actor-informant. The distinction of emic mental data relieves an investigator from "trying to get inside the head of a native", or deciding when an informant is lying or simply mistaken. By definition, it is simply not possible for an informant to produce "wrong" emic-mental data.

I developed a number of fieldwork techniques to both find evidence of past thefts and monitor thefts while they were occurring. One Tuesday while walking along the embankment of the Sanhour Canal, I noticed a significant amount of water seeping around a barrier stone meant to stop water flow to a side feeder canal. The size of the spilling flow raised suspicions about the accidental nature of this "leak" so I followed the path next to the smaller canal in which the diverted water traveled. After about 300 meters I came to another sizable "leak" at a holding stone of a large canal into this smaller canal. In three or four hundred more yards the water spilled into a small field planted with young citrus trees and peppers. There was no one there so I walked over to find some shade against a large date palm. After sitting for over an hour against this tree, a man rose from napping in some near by bushes. He greeted me, introduced himself as Hakeem, and asked me to join him for some refreshments.

Hakeem had the usual curious questions concerning just what a foreigner was doing walking around the countryside. He had heard rumors of my existence but we had never met. We roasted some corn, ate dates and visited for an hour or so and I made arrangements to come back and visit him in a few days. I asked him nothing about the water spilling into his field.

Subsequent visits with Hakeem established that the young orchard receiving water was his and that Saturday, not Tuesday was his allotted day for receiving water. This simple method of watching when and what farmers did rather than relying solely on what they said was most useful in learning about water theft. It was thus possible to study water theft behaviorally, independent of interviews and emic/mental statements on the topic. The system of fixed days of irrigation made it possible to monitor some aspects of water theft, though it was also necessary to check if irrigators had borrowed or traded time with other irrigators. In the above example of Hakeem I would discount the possibility of him having borrowed the water because of the limited flow to the field, which was clearly intended to appear as an accident.

I also checked the dampness of feeder canals and fields whose schedules were known to me. None of these techniques of monitoring water theft and its traces are beyond the capacity of Fayoumi farmers. In fact, I recorded one instance where a man was accused of pilfering water because his field was found to be soaked one morning when he had no irrigating rights. He claimed innocence, and simply suggested that water had spilled into his plot during the night. Most farmers will tolerate some degree of water theft from neighbors before they are willing to become involved in issuing formal or public accusations against an individual. I believe one of the reasons for this is because of the widespread occurrence of water theft throughout the society, and a recognition that at some point in time all irrigators have themselves stolen water.

There are a number of techniques which farmers employ to illegally increase their water share: beginning to irrigate prior to their allotted times; continuing to irrigate beyond their allotted times; opening spillways from surrounding fields or canals; using a tambour (Archimedes screw), especially at night; and even conspiring with neighbors to ignore the time limits of their specific water shares. A great deal of the water theft of which I was aware occurred at night, or after the occasional winter rains when the presence of damp ground would not seem anomalous. There are often angry words between neighbors over the presence of a wet field, days after the allocated watering period.

I did observe instances in which authorities from the Ministry of Irrigation were called to investigate and eventually prosecute water thieves. Farmers always tried to solve disputes before calling in state officials. Though there was always a clear reluctance of community members to take sides in these disputes, but it was equally clear that coalitions on the sides of the accuser and accused had been formed prior to the arrival of the irrigation police. As would be expected, most coalitions were formed on the bounds of kinship and previous alliances relating to other issues in the community. During the eight times I observed the interdiction of the state in these disputes, the accuser always owned more land than the accused and in two instances the accused were share croppers who did not own the land they farmed.

Admissions of Theft

Sebring raises points concerning the inevitability of outside observers generating bogus emic/mental responses to questions concerning ethically questionable activities (Sebring 1987). He found that after living in a community in southwestern India for months, his informants began telling him that they were involved in the culling of cattle. To him this study invalidated Harris' fieldwork of the 1960s and was a further negation of the utility of the concepts "emic" and "etic."

Like Sebring in India, I also found that with time, my informants in the Fayoum became more willing to discuss water theft and even to admit to being thieves themselves. This is of course no surprise, and certainly does not threaten the utility of using the diagnostic categories of emic and etic. If anything, the very malleability of such emic/mental data would seem to raise doubts and questions about research which relies primarily on such data for the formation of its models.

After living in the Fayoum about eight months, a number of informants began to privately admit to me that they occasionally stole water. Among farmers who admitted water theft the overwhelming sentiment was that theft was necessary for survival, especially during a period when new orchards were first planted and water was crucial. Many informants never admitted to engaging in water theft, including some individuals for whom I had evidence suggesting they were indeed water thieves.

One informant claimed that his theft of water was his only defense against the manipulation of the water schedule by the munawaba leader. He stated, "I steal only as he forces me." Water thieves always described their actions as defensive rather than offensive.

Engineers planning an agricultural feasibility study of the Fayoum noted,

> Ad-hoc modifications have been made to the supply channels and their structures, but the precise values cannot be determined without a detailed survey of the supply system. The smaller control structures are commonly damaged by farmers in order to obtain more water than their share, which is often wasted, particularly at night, by running to the drains. (F.A.D.P. 1982:8)

In one of the few published studies of irrigation water theft, VanderMeer found that in Taiwan, water thieves admitted to stealing for reasons of convenience (relating to scheduled times) and to a perceived necessity (VanderMeer 1971:160). VanderMeer's study of water thievery among Taiwan rice irrigators identified distance from water source as being the principle variable, though in this system farmers closest to the water source took advantage of proximity and stole water before it could be delivered to those below them (1971:162). VanderMeer concluded that "whether one farmer was more willing to steal than another depended upon the sort of relationship he had with the farmers from whom he could steal" (1971:169). Clearly more work must be done on the importance of inter-field irrigation dynamics to see if ecological constraints limit possible forms of land tenure and water use (see Coward 1990 & Pasternak 1968).

It was not possible to gather data on the complete frequency of water theft as it relates to field position (and conveyance loss), but in no instance did I record any evidence of theft by irrigators within four plots of the source canals. The greatest number of thefts occurred on plots located at distances beyond 200 meters from the source canal.

Though the institution of widespread ownership of private land in Egypt is only a few generations old, the advantages held by a plots proximity to a canal can be seen in the present state of land holdings. Most individuals who own over five feddans of land have their principal holding within one hundred meters of the main feeder canal. The long term advantages accrued by a plot's inter-field position can thus be inferred by the owner's ability to buy out the holdings of less successful, and assumedly more distant farmers.

Does Theft Mean the State is Weak?

What does the high frequency of water theft imply about the strength and power of the Egyptian state? Obviously the state is not an omnipotent power when such frequencies of water theft regularly occur without penalty, but does this in itself argue against the "necessity" of a centralized state? I would argue that it doesn't. Instead, the prevalence of water theft suggests that Egypt is a relatively weak centralized state which is not concerned with this secondary feature of production. But Egypt is a centralized state with the strength required to oversee the technology required for the irrigation system to function (not to mention the military strength of the Ministry of Interior to squelch internal unrest and indigenous revolutionary movements). The state is primarily concerned with maintaining the irrigation infrastructure that is in place, not with running about the countryside enforcing the rules and regulations of water distribution. But as shown in the previous chapters, for the Fayoum the state's role in delivering water is very significant.

Mehanna et al. believe that the "minor bits of overdue maintenance and undersupervision are the only warts on an otherwise smoothly functioning water delivery system at the local level" (1984:140). The systemic "flaw" of overdue maintenance is blamed on the weakness of the Ministry of Irrigation,

> That flaw is the weakness of the Ministry of Irrigation at the lowest level of its responsibility. The vacuum left by Ministry non-performance is filled by the "illegal" water appropriation activities of farmers: pumping directly from canals or from drains, altering <u>mesqa</u> in-takes, laying illegal pipes in canal banks and diverting water from <u>mesqas</u> on other rotation cycles. (Mehanna et al. 1984:140)

I would never argue that the Ministry of Irrigation operates on a highly efficient level. The stagnant inefficiency of <u>any</u> Egyptian Ministry is obvious to anyone. My point is simply that the Fayoum's irrigation requires supra-local hydraulic supervision, the exact efficiency of this supervision is a separate matter: the current state of the state is disastrously inefficient, but in the end it is <u>efficient enough</u>.

In an article on bureaucratic based irrigation systems Susan Lees observed that:

> A farming family's ability to survive in the context of bureaucratic constraints depends on both the adequacy of its means of manipulating the rules while appearing not to break them, and on the compliance of others by failure to correct prohibited or unauthorized irregularities. (1986:610)

she even goes so far as to say that in some Israeli collective settlements "up to 70% of the water used is unaccounted for (stolen!) by tampering with outlets and meters" (parenthesis and exclamation hers) (1986:612). The widespread cross-cultural occurrence of such illegal practices renders a great number of the normative studies of community level irrigation societies obsolete.

The fact that farmers in hydro-bureaucratic systems do not comply with all the rules does not weaken arguments for the presence of hydraulic states. Instead, it depicts a weaker omnipresent state than is suggested by Wittfogel and others. It also demonstrates the abilities of farmers to optimize the disadvantageous position the state has placed them in. The available water is a given, but an individual's share relative to his neighbors can be changed through actions outside the state imposed rules. No state can ever control everything. Even the most despotic of states always have some form of a black market regardless of the penalties or the strength of the state.

Another way of looking at Fayoumi water theft is that, in the end, the state directly profits (through taxation) by the success of farmers who steal water, while conversely the failure of these same farmers would provide nothing for the state.[4] The state does have a laize fare attitude towards water theft occurring below the last weir, but it is hard to imagine it having any other attitude. How could it ever hope to enforce such violations?

Summary and Conclusions

Conveyance loss in the Fayoum effects agriculture and the economic success of farmers. Partly as a result of conveyance loss, legal and illegal methods of increasing water access are used. Fayoumi farmers have come to rely on magrur compensation and water theft as means of circumventing the deleterious effects of conveyance loss.

There are also aspects of up- and down-canal relationships which (in certain technological circumstances) determine an irrigator's ability to instigate irrigation maintenance. My simple adaptation of Freeman's test illustrates the nature of power in up- and down- canal relations, but it also reveals much about the role of technology in society and evolution. When it comes to implementing irrigation maintenance, up-canal irrigators are more powerful than their down-canal neighbors. Though the up-canal irrigators in gravity and saqqiya communities have a greater control over maintenance decisions, there was still an overall greater degree of inter- dependence amongst members of the irrigation community, than that found in pump communities. Irrigators in communities reliant on pumps for water lifting were "more equal" in their ability to instigate irrigation maintenance, but this "equality" was also manifest in their greater negligence in maintenance activities (i.e. they all let the system deteriorate at equal rates). The interesting exception to this of course were the pump owners who had greater control over such decisions.

The maintenance dynamics of the pump communities is a small representation of a larger social pattern which results from technological innovations. The adoption of new water lifting technologies created new levels of technological dependencies and weakened existing levels of social dependencies. This new technology also allowed irrigators to ignore ecological degradations by simply increasing their dependency on this new technology.

I don't believe that Egyptian farmers are mindless, unconscious automatons who are unaware of the world around them. On the contrary, they are acutely aware of the particular requirements of their individual environmental settings and as such take precautions to improve their chances of agricultural success. It would seem that Egyptian irrigators did not state as an emic rule that a plot's distance contributes to water theft because this systemic pattern is beyond the reach of their daily lives. They may even be well aware of it, but the knowledge has no utility--it cannot be connected to their sphere of influence or political action. The impact of conveyance loss is dealt with on an independent, individual basis. Individual irrigators perceived their own water shortages but did not emically connect this with the inter-field magrur problem.

Water theft in the Fayoum does not simply occur in a vacuum. It predominantly occurs as a result of etically measurable conveyance loss, and is most frequently emically justified as a defensive posture against what are perceived to be the actions of up-canal thieves. I found that there was little emic/mental consciousness of conveyance loss presenting an identifiable problem. Informants did not generally state the emic rule that distance from a water source was a contributing or determining factor in water theft. Yet the correlation is easily discovered and, at some level, they must be aware of it.

Notes

1. I had originally built and tested a high quality aluminum rcb weir in the U.S. and packed it for shipping to Yemen. I brought along the plans necessary to build another one in Egypt. The gauge was portable, its size was 50 x 20 x 70 cm. though it was heavy it could fit on the back of my heavy frame bicycle or on the roof of a bush taxi.

2. All measurements were taken with one, 100 cm, RCB portable flow gage which was constructed in the Fayoum (see Bos et al. 1984; Replogle et al. 1979). This was a bit heavy but could be moved throughout the Fayoum in service-taxis, or on the back of my heavy Egyptian bicycle with ease.

3. This view is at odds with Mehanna et al.'s analysis of the effects of different water lifting technologies. Mehanna observed that when farmers need to use a pump they usually form some type of pump-group to share the costs involved in renting a pump.

> Pumping, in contrast to the individualistic nature of gravity and tambour irrigation, is usually a collective enterprise. (Mehanna et al 1984:84)

I believe that this view is only true in terms of the short-term differences between lifting requirements, but fails to recognize the significant long-term differences in maintenance organization between pump and gravity communities.

4. This is of course only a short-term view (but the short-term is unfortunately the arena in which evolutionary selections are made, no matter how long-term their consequences might be). In the long-term the lack of water conservation practices and regulation stands to threaten the national security of Egypt (see Waterbury 1978 & 1979).

CHAPTER 13
THE STRENGTH OF THE STATE IN THE FAYOUM

Natural selection loves a winner, but hates a show-off.
--Papworth's Law.

Important Differences: Strong, Weak, Omnipresent and Omnipotent

There is still little consensus among social scientists on issues concerning the strength of the contemporary Egyptian state. Some describe the Egyptian state as "stalled" (Ansari 1986) or "soft" (Sadowski 1991:121), while others declare its grasp to be "intrusive" (N. Brown 1990:215). I believe the effective power of the Egyptian state falls somewhere between these characterizations.

On the whole, the contemporary Egyptian state is--seemingly contradictorily--both weak and omnipresent. Its strength varies from region to region, and in the Fayoum it tends to be stronger than elsewhere. As a pseudo-socialistic bureaucratic state, it has ministries and bureaus that spread out from the capital to villages everywhere--though the degree to which the state can effect change is not as widespread as its geographical presence. In this light, the power of the Egyptian state can be seen in its ability to inhibit change, and to maintain its status quo grip on monopolistic power.

It is in part Egypt's particular form of bureaucratization that helps create the impression of a powerless state. As with any bureaucracy, Egypt's labyrinth of Ministries and Bureaus provide a mechanism for the denial of responsibility and distance for individual policy makers, and those whose job it is to enforce these policies.

The most recent example of the Egyptian state's all-present powerlessness is found in the governmental response to Cairo's earthquake in the fall of 1992. The state's inability to effectively respond to the needs of the quake's victims was highlighted by the grass-roots success of various Islamic fundamentalist groups. The political significance of the superior speed with which these decentralized groups could provide food and shelter was not lost on either the Egyptian government or the populous. The relative effectiveness of the fundamentalists delivery of humanitarian aid reaffirmed the belief among many Egyptians that such groups would be a welcomed replacement for the present regime (arguably, these fundamentalist relief efforts were the factor leading to the increased arrests of fundamentalists in the months following the quake, see Hedges 1992).

The Egyptian government is undeniably everywhere, but just what it is(n't) accomplishing there is the factor leading many analysts to conclude that it is powerless.[1] Take, for example, Richard Adams' conclusion that the Egyptian state is more concerned with controlling than improving rural agricultural production (Adams 1986). I agree with this assessment completely, but from this situation it does not follow that Egypt is an ineffectual or powerless state: only that it has a greater interest in preserving the status quo than in improving the lot of the rural masses.

In a negative sense, the strength and power of the Egyptian state is shown in the depth of byzantine bureaucracy required for virtually <u>any</u> interaction between individuals and the state. Little in Egypt can move without the state's cooperation. Through its dictation and regulation of everything from cropping schedules, seed loans, guaranteed governmental employment to college graduates, duties and taxation, mandatory drafting of young males, to its price fixing on staple food items: the state interferes--inefficient though it may be--in the daily lives of all its citizens. The state is everywhere, though the degree to which it assists the populous it comes in contact with is questionable.

It is this predominant <u>inefficiency</u> of state interference that has led many analysts to incorrectly conclude that the modern Egyptian state is impotent. The inefficiency of the Egyptian state is undeniable and obvious to anyone who has ever lived there. But as countless (dead and imprisoned) Egyptian dissidents have discovered during the past few decades it is a serious mistake to confuse inefficiency with impotency.

I do not pretend that the Egyptian state is capable of controlling the minute details of its citizens' lives, or even that its dictates necessarily result in compliance. Some anthropologists and political scientists falsely assume that to argue for a centralized states is to argue for a sort of thought-police that physically intervenes each day at a household level. For example Adams writes that:

> To assume that the state is able to control the daily lives of peasant cultivators is to greatly overestimate the state's power of control over both its own officials and members of the rural sector. (Adams 1986:78)

This view errs in confusing an inefficient or weak state with state failure. It is as if critics of the centralized state model suppose that this state would require an efficient process of totalitarian extraction that would leave only enough blood in its citizens veins to just barely sustain life and nothing more, or that the state be a paragon of efficiency. Adams further complains that Egypt has failed to effectively capture its base of potential fellaheen clients. He even concludes that,

> In Egypt. . .the state has <u>never</u> made any serious attempt to capture small or poor peasants in order to technologically transform the basic factors of agricultural production. (Adams 1986:82, emphasis added)

"Never" is certainly too long a time to consider such a statement, even a cursory examination of post-Nasser irrigation projects leads us to reject this claim (nevermind a consideration of the state's role since Dynastic times). It was Brecht who asked us "who built the pyramids?", and now we must in turn ask Adams who dug the canals, built weirs, performed the labors of gafaf, and constructed all the networks association with the Aswan dam?

Egypt is an inefficient centralized state that has exploited and squeezed its population to the limits of its abilities (or to the limit it dares). Even so, it is "efficient enough." There is evidence of this tactical approach everywhere. One evidence of the edge of minimal efficiency which the Egyptian occupies, is seen in the extent that armed opposition movements seem to be waiting below the "calm" surface of daily life. The tragic bread riots of 1977 (in which 73 people were killed, over 800 injured and over 1500 arrested) and the reluctance of the Egyptian government to now raise subsidized bread price in accordance with the demands of the IMF is proof enough of the thin line separating the legitimate state from an open rebellion. Egypt's abysmal human rights record is enough to quite objections of its characterization as a near-totalitarian state (inefficient though it may be). With over 7,000 political prisoners unaccounted for and countless others simply "disappeared" by the Ministry of Interior, there should be little question about the extent and power of Egypt's exploitative centralized government (Abalalla 1988; Abdel-Malek 1962; Heikel 1983).[2]

The state's relatively strong presence in the Fayoum has surely contributed to it becoming such a hot-bed of Islamic fundamentalism, and potential revolutionaries (the Fayoum's most famous celebrity is the exiled blind cleric, Sheik Omar Abdel Rahman--most recently tried and convicted by the American media as the ideological impetuous behind the 1993 bombing of New York's World Trade Center). The violence of these Fayoumi groups is directed at the state as much as it is at the Copts (see Ahmed 1992; Aikman 1991; Berger 1970; Botman 1987; Haddad 1987; Ibrahim 1993; Kepel 1984; Landau 1965; Leif 1991; Moriah 1963).

Is the State Stronger in the Fayoum than Elsewhere?

For much of Egypt today, the state does not regulate or maintain canals beyond a very minimal level, and even ignores violations of water rights at times, but in this regard the Fayoum is different from the rest of Egypt. The Ministry of Irrigation interferes and regulates irrigation in the Fayoum at rates higher than in other provinces. The reason for this high level of state interest, and interference in the Fayoum is partly linked to the environmental-technological aspects of its particular form of gravity-fed water delivery. The peculiarities of the

Fayoum's gravity fed irrigation necessitates a greater level of order and maintenance than do other areas of Egypt.

Throughout Egypt the extent of the state's intervention in the hydraulic activities of fellaheen varies from region to region. If the Fayoum's irrigation system were allowed to fall into a state of disrepair as severe as that of the rest of Egypt it could not as easily compensate for this by individual irrigation groups converting to pumps for water lifting. Each network of primary feeding canals would instead need to have pumps working night and day at their source, with further pumps being necessary along the irrigation routes. These pumps at canal headwaters would still need to be run and maintained by some sort of group whose power was beyond that of a local irrigation group.

The state's high level of involvement in Fayoumi irrigation systems is not as great as it could be (or has been in the past) but it certainly is necessary for the current irrigation methods to function. Compare what we know about the Fayoum's upkeep of irrigation works with Richard Adams' characterization of the irrigation canals of the Delta village of Zeer:

> When the King arrived in Zeer in the late 1920s, he installed a relatively sophisticated irrigation system. In the King's time the vast series of secondary and tertiary canals and ditches in this irrigation system were regularly cleaned by fellahin working under the threat of the whip. Every floodgate in this system was manned by a watchman, who opened and closed that gate according to a strict time schedule devised by the King's agricultural staff. Today, however, no one wields a whip over the fellahin. Most of the

> floodgates are broken and the watchmen have nothing to do but to collect their salaries. (Richard Adams 1986:113)

Adams' description is one of managerial collapse. Individuals are left to fend for themselves and the responsibilities of the state are minimal. The mention of gate watchmen who "have nothing to do but collect their salaries" is an excellent example of Egypt's weak state where bureaucrats prevail regardless of whether or not they have actual functions. But this state of managerial collapse cannot be understood apart from the technological base supporting it. The presence of pumps along the Nile and Delta have been selected through the principles of a "law of least effort" (see Sanderson 1990:187). Local technologies allowed these irrigators to overcome their reliance on the state, or put another the way, the state no longer needs to expend managerial energy where user managed pumps can do the job.

It is the dependence on pump based irrigation that established the highly independent irrigation practices observed by Nickolas Hopkins along the Nile Valley of Upper Egypt.

> The state pretends to regulate everything and in fact regulates nothing. The Irrigation Service does not interfere with the way water is used in the village; and the Ministry of Agriculture is concerned with assigned acreages and yields, not with the engineering of water application. Thus this activity largely escapes government supervision. (Hopkins 1987:98)

Waterbury cites an unpublished study of pump based irrigation along the Nile Valley that reaches similar conclusions concerning the state's control over irrigation.

> A general lack of enforcement regulations suggests that farmers manage the system more than the Irrigation Department. Unauthorized outlets exceed authorized outlets at least three times, unauthorized pumps are used, laterals and outlets on the main canals use water out of turn, turns on laterals are extended to reduce farmer complaints and farmers use water on a system more nearly approaching demand than the authorized rotation system. (cited in Waterbury 1979:222)

In the Fayoum, if "unauthorized outlets exceeded authorized outlets by at least three times" the system would quickly collapse. Accordingly, the state must rigorously supervise the flow of Fayoumi water.

Both of these passages share the common view that violations of irrigation rules and laws along the Nile Valley and Delta are commonplace to the degree that the state is practically powerless. The Nile Valley and Delta's modern reliance on pumps for water lifting allows for a relative laissez faire approach to irrigation scheduling and this results in widespread water theft. The key to understanding the above passages is the technological implications of pumps in freeing the state from its duties of irrigation maintenance and scheduling. New infrastructures create new social orders. In regions where pumps are the rule, the duties of the centralized state are no longer required. This is not to say that the bureaucratic bodies once necessary for the system's functioning cease to exist, only that their powers diminish. The adoption of pump technologies along the Nile has brought with it new problems and concerns. When individuals go out of turn or take longer than their allotted time along the Nile Valley and Delta their primary concern is over the procurement of a pump rather than the limited supply of water as is the case for most farmers in the Fayoum (cf. Hopkins 1987; Mehannah et al. 1984).

The widespread reliance on gasoline pumps in the Delta and Nile Valley allows continued farming (though at reduced rates of productivity) without regular canal maintenance. With the current levels of available technology along the Nile, canals that are filled with silt (through maintenance neglect) are still usable. Without these pumps such acts of negligence would not allow the continued irrigation of surrounding fields. In the Fayoum, such levels of disrepair would quickly cripple the irrigation network system. Such high levels of canal silting and clogging in the Fayoum would both render the necessary sluice gates inoperative and reduce the amount of available water to rates that would cause crop failures.[3]

At a Minimum, A Weak State in Necessary for Agriculture in the Fayoum

At a minimum, a weak state is necessary for current levels of agriculture in the Fayoum. The state's coordination of irrigation in the Fayoum is necessary to maintain water delivery at present levels. In fact, state hydraulic management is now required if Fayoumi farmers are to survive. The management of water delivery via Bahr Yusef, the Ibrahimia Canal and the Nile is complex beyond the capacity of small non-state structures. With the present ecological and technological conditions it can truly be said that: At a minimum a weak state is necessary for agriculture in the Fayoum. A stronger state could increase agricultural productivity (by reclaiming lands, intensifying maintenance) to some degree though it is not clear that these increases could pay for the costs of a stronger state presence.

But outside the Fayoum, there is a general decay of irrigation works. The levels of technology available to the modern fellaheen do not necessarily require a strong or despotic state for this system to function (though the larger irrigation works do require an expansive tax base to support their purchase, upkeep and use).

People need motivations to undertake the arduous tasks of upkeeping thousands of kilometers of interconnected canals. The motivations, contingencies and metacontingencies required for village based--as opposed to state based--maintenance are found only in cultures where the canals and technology required for the system's operation are proximate.[4] If villages throughout Egypt and the Fayoum were left to clean and maintain canals without any over-arching (in this case centralized) plan or supervision there would be no effective irrigation in the Fayoum at all. The costs and benefits for Fayoumi irrigators would not be the concern of villagers 100 or 200 Kilometers up the Bahr Yusuf Canal as they decided whether or not to put labor into dredging the canal.[5] There are strong contingencies governing the benefits enjoyed by irrigators who maintain canals in their immediate area. But it is impossible to find an ethnographic example of any culture opting to devote sizable labor for geographically distant groups without the coercion of the state.[6]

Lest anyone misconstrue this argument as some sort of advocation for strong states, it must be said that the state most clearly does not make its decisions based on the quality of life or human rights of the individuals beneath its power. States are made by extraction of surplus and breed social stratification rather than equality. To say that the Fayoum's irrigation requires supra-local planning and control, is a long way from endorsing the repressive tactics of the sometimes vicious Egyptian state.

Telephones, paved roads and railroads simplify the required coordination of such a large-scale irrigation system. Heavy machinery and improved engineering replace past levels of labor needed for construction and maintenance of irrigation works. Though these changes appear to have reduced the demands and constraints the state places on irrigators, these changes have not in any way liberated irrigators from their subservient position to the beckon and call of the state Ministry of Irrigation and indeed make supervision all the more possible. As Nathan Brown noted of the fellaheen's suspicion of new technologies introduced earlier in this century:

> If peasants were suspicious of telephones, for example, it was not because they were unfamiliar and new but because telephones were used to police them. (N. Brown 1990:215)

As we have seen in the previous chapters, throughout the Fayoum's historic past, at the very least a weak but omnipresent state was required for any degree of agricultural success and that individual's agricultural success was determined by their water access. This said, it is important to stress that both the form of the state's power and the way in which wealth was determined by water access have occurred in different ways at different times. There have been a variety of both "strong" and "weak" states in Egypt's history but the degree to which each supervised, maintained and constructed irrigation works in the Fayoum determined their agricultural success in the region.

Is the Fayoum Representative of the Rest of Egypt?

The evidence of the state's strong hydraulic presence in the Fayoum begs questions concerning the Fayoum's hydro-administrative representativeness of the rest of Egypt. There are two parts to such questions, with each part having a different answer. First, is the Fayoum's hydraulic situation today representative of the rest of Egypt?

Second, was the Fayoum's hydraulic situation in the past representative of all of Egypt? These are two separate questions, which (due to mitigating technological and ecological circumstances) have two separate answers: Today no, yesterday yes.

Over a century ago the French hydraulic engineer Julien Barois described the paradox of Egyptian irrigation as one in which "on the one hand the government assumes all authority over irrigation, and on the other the individuals are subjected for the use of the water to no specific regulations" (Barois 1889:100). For most of Egypt, Barois comment of a hundred years ago still rings true. The state still insists it controls irrigation in general, yet outside the Fayoum it fails to prosecute many of the most blatant violations of irrigation law. The disrepair of most of the country's irrigation work indicates an apparent lack of state control over irrigation activities. While the state's interference in irrigation may be minimal for most of Egypt, it is not quite so simple in the Fayoum.

Because the Fayoum's land is below sea level, and has an unique gravity-fed irrigation system, the state assumes a distinctly important role in supervising water allocation and system maintenance. The reason for this is that, as long as canals are maintained and cleaned the sloping elevation of landforms allows water to be delivered without the use of pumps. As long as the canals remain clear, agricultural production is high. It is this predicament that keeps the state involved in distribution and maintenance at such high levels in the Fayoum.

This higher level of maintenance, and state coordination in the Fayoum is nothing new nor is it without proportional economic returns.[7] The Fayoum has consistently required a high level of centralized hydraulic coordination. Given a certain level of technological capacity and sophistication (e.g. canal irrigation networks and water lifting devices) the Fayoum Basin has a corresponding requirement of intensive supra-regional state level regulation.

Does the recognition that the Fayoum's irrigation management differs from the rest of Egypt disqualify larger generalizations about the role of a centralized Egyptian state that can be made from Fayoum data? It does not. First, the contemporary Fayoum's overall reliance on gravity-fed and animal-drawn water lifting technology more closely resembles the whole of Egypt's pre-Aswan hydrology than that of any other region. As Egypt's irrigation outside the Fayoum has increased its reliance on pumps, the need for state management has diminished. In this sense the Fayoum acts like a time capsule for the levels of state coordinated maintenance and scheduling feats necessitated in the Nile Valley before pumps dominated irrigation activities.

Second, the Fayoum's current and historical requirement of centralized state managed irrigation informs us about the state's ability and inclination to regulate irrigation activities outside the Fayoum. Historically, the governmental structures that have managed irrigation in the Fayoum have only been local branches of administrative bodies functioning throughout Egypt. Minimally, a highly organized regional government would be necessary for Fayoumi irrigation to function, but Fayoum irrigation has always been managed within the direct confines of the larger centralized Egyptian state (whether the administration was Pharaonic, Ptolemaic or Nasserist). The past governmental organs supervising Fayoum irrigation have never greatly differed in kind from those that managed Egyptian irrigation outside the Fayoum Depression.

Is Contemporary Egypt a Hydraulic State?

The Dynastic Egypt state was a classic hydraulic society, with an Asiatic mode of production. The central state's power was directly tied to the hydraulic mode of production. But strictly speaking, the contemporary Egyptian state is not a hydraulic society.

The lack of a state monopoly on property, the importance of non-hydraulic activities in the larger economy and the relative independence of Delta and Nile Valley irrigators from state schedules and regulation make it inappropriate to characterize Egypt as a hydraulic society--

though it is in someways akin to one. Though most Egyptians are dependent on irrigation agriculture, most of Egypt's irrigators do not currently require a hydraulically-centralized state.

But the current high levels of state interference, subsidization, regulation, and centralized control of modern Egyptian irrigation and agriculture--especially in the Fayoum--are a link with Egypt's ancient hydraulic-despotic past. There are still many activities directly and indirectly related to irrigation that are organized or controlled by the state. One such example is the institution of gafaf, the yearly period of mandatory canal maintenance labor that is the modern behavioral equivalent of the state managed corvee of the past.

For most of Egypt, technology (primarily pumps) allows irrigation to limp along at (close to minimally) acceptable productive rates without centralized state management. Most of the fellaheen (outside of the Fayoum) do not immediately rely on the state for the delivery of their irrigation water. True, they do rely on the state for the management of the Aswan Dam, and thousands of major and minor canals, but Egypt beyond the Fayoum is agriculturally productive without high levels of state irrigation coordination.

Summary & Conclusions: Strong States, Weak States, Steady States

As an evolutionary category, "the state" encompasses a variety of specific social formations. There are great differences in the specific mechanisms of state rule. The ruling power base can be centralized or decentralized. Decision making can be dictatorial, democratic, monarchical. The economic distributive system can be range from capitalism to socialism. Despite the diversity of state forms the use of this single evolutionary classification is still justified. All forms of the state share more similarities than differences. Each is highly stratified, has a minority of elite rulers who collect taxes from the bulk of the population and has the resource of force to assist in the implementation of rule.

The issue of the modern Egyptian state's level of involvement in regulating irrigation is as controversial as ascertaining its involvement in more ancient times. The degree of centralized power held by the Egyptian state has varied throughout its history, but there is no denying the presence of a some sort of centralized state administration. Today, most anthropologists and political scientists studying Egypt are focusing on factors other than the state's infrastructural basis in power. In fact,

> Gone. . .is the perception of Egypt as a "strong" state--ironically, at a time when political scientists are being urged to bring the concept of the state back into their theoretical analysis. . . .For a region so

> well known for authoritarianism, is it not perplexing that the strongest state in it is actually weak? (Hudson 1991:411)

Such analysts somehow confuse omnipresence with omnipotence. The recognition that the present Egyptian state is simulateously omnipresent and weak accounts the state's contradictory all pervasive and inefficient condition. The current Egyptian state is both weak and "strong enough"--though the growing crowd of potential revolutionaries certainly un-nerves the present state.

The fact that the Egyptian setting has continuously led to the selection of various degrees of centralized states is indicative of Egypt's administrative needs. Historically, this has had everything to do with the hydraulic needs of the countryside, though today the widespread use of pumps through most of Egypt has changed the dynamic of this dependence.

Notes

1. To borrow an image from the biological sciences, it is as if the State has opted for a survival strategy based on R- rather than K-strategies. The Egyptian state's strategy is based on its sheer size rather than on high levels of efficiency for its survival and maintenance of power.

2. In the first and last instance the ability and power of the state to govern is more military than market or managerial:

> . . . if the state exploits the citizen, it is not a form of market exploitation. . . . The state, if it exploits, does so through its monopoly over the means of violence (Elster 1985:198).

3. The Fayoum could let all the canals clog and then use pumps to lift water but this would require pumps operated by the government at strategic positions, thus strengthening the role of the State even more.

4. This is the explanation of why Sri Lanka, Bali, Yemen and Japan (hydroagricultural societies) never evolved strong, state-controlled irrigation empires: high returns were accomplished through the proximate control over irrigation works while diminishing returns would be the result of expanding irrigation control beyond localized holdings.

5. For more on the role of contingencies and metacontingencies in cultural evolution see Malagodi 1985; Malagodi & Jackson 1989; Glenn 1991 & nd.

6. Though cultures have often opted to devote large amounts of labor for others (descendants) who are temporally removed from them.

7. Even anti-state-centralist hardliner Karl Butzer conceded that the Dynastic Fayoum may have been a special case in Egypt's Dynastic evolution because of its high levels of State construction and maintenance of irrigation (Butzer 1976:108).

CHAPTER 14
CONCLUSIONS: SUMMARY OF ARGUMENTS

Historical Continuity: Evidence for a Centralized Payoff

Cultural evolution in the Fayoum has been shaped by the waters flowing into its depression. Even during the Paleolithic and Neolithic Periods, Fayoumi cultures were constrained and nurtured by the nature of the water supply. These populations moved with the rising and falling water levels, eventually settling along the lake's shore during the Neolithic, where they farmed and fished. The Fayoum's neolithic sites are among Egypt's earliest and preserve a clear picture of the small pre-state communities spread throughout Egypt prior to the formation of the Dynastic states.

At the end of the Neolithic, more and more sedentary villages were established along the Nile Valley and Delta, population levels reached a point of critical mass and polities engaged in raids which later intensified into warfare over the territoriality of a cirumscripted environment and access to limited resources. These were the ecological and demographic conditions that produced the first states of Egypt.

The Dynastic states built, controlled and maintained a massive irrigation infrastructure spanning thousands of kilometers. This was a period of technological innovation, population increase, increased costs of living, and increased suffering among the poorest of the population (c.f. Harris 1979:272 description of other revolutions in production). As recognized by Wittfogel (and later Steward, White, Harris and others) irrigation based societies throughout the world evolved under similar circumstances. The Dynastic evidence of a hydraulically centralized state in the Fayoum is so overwhelming that even weak-state theorists such as Karl Butzer are forced to declare the Fayoum is an exceptional case (Butzer 1976:108).

In reality the Dynastic Fayoum was not a hydraulic exception. It was simply a region where the residual evidence of the state's hydraulic projects are more archaeologically apparent: the Dynastic canals and dikes elsewhere in Egypt have been used, filled and rebuilt for thousands of years so that their existence can be more easily ignored by those with such theoretical inclinations.

The Ptolemies approached the Fayoum's irrigation with the long-term planning befitting a well-funded foreign administration. A regulator at the Fayoum's entrance was installed, thousands of kilometers of canals were dug and new water lifting technologies were employed, bringing irrigation water to distant regions which even today are deserts over thirty kilometers from water. It was during the Ptolemaic administration that the Fayoum's crucial dynamic between centrally enforced maintenance and productivity came into play. This dynamic balances maintenance requirements and regional productivity in the following way: The extent to which an administration re-invests agricultural profits in the maintenance or improvement of the irrigation system determines the overall success of agricultural ventures in the Fayoum for a given period. It is a dynamic that has regulated the success or failure of agricultural ventures from the Ptolemies to the present.

The earliest Roman administrators saw the value in restoring most of the Fayoum's irrigation works neglected by the later day Ptolemies. Rome was more concerned with exporting grains to the greater Roman empire than with the long-term sustainability of the Fayoum's irrigation system. With time, the Romans over taxed Fayoumi farmers without adequately returning a portion of these taxes for the maintenance of local irrigation works and the Fayoum's agricultural returns diminished. The effects of conveyance loss on productivity became clear as down-canal villages were rapidly abandoned by farmers fleeing to avoid persecution by the state.

The lack of any consistent centralized irrigation control for over a thousand years (following the Roman period) left the Fayoum in a condition of general disrepair. Nabulsi records the dehabilitating effects of the Medieval decentralization of authority. As villages and private estates became the locus of authority, the overall effectiveness of the Fayoum's irrigation system deteriorated. Again, the riparian determinants of up-canal/down-canal relationships favored the farmers, villages and estates located nearest to the main canals of this decaying system, those located down-canal suffered the most.

Mohammed 'Ali renewed the state's centralized control over irrigation. Mandated corvee captured the labor of the fellaheen and transformed Egyptian irrigation works throughout the countryside. In the Fayoum this meant that old canals were reclaimed and new methods of perennialization were installed. These changes brought significant agricultural returns, but the costs of these improvements (as well as other non-agricultural changes) weighed heavy on Mohammed 'Ali and the administrations of his kin which followed. When Egypt finally entered an international receivership, the British and French hydraulic engineers further recognized the Fayoum's hydraulic potential and reworked the system of distributory weirs.

The Officer's Revolution brought limited programs of land reform and ambitious perennial irrigation projects associated with the High dam at Aswan. The post-Nasser availability of pumps changed Egyptian irrigation as much as

Mohammed 'Ali's perennialization projects did. The end result of the widespread availability of these pumps along the Nile has been a reduced reliance on the Ministry of Irrigation for the coordination of irrigation.

Since the days of the Nasserist revolution the bureaucratization of the countryside has exploded bringing rules and regulations to the basic productive activities of daily life. The current reliance on pumps along the Nile Valley and Delta frees the Ministry of Irrigation from many maintenance and repair responsibilities, though this is clearly not the case in the Fayoum. While the rest of Egypt's canal systems are allowed to function in a condition of disrepair, the Fayoum's gravity-fed system requires state led maintenance at levels other regions have not experienced since their conversion to pumps. The current state's regulatory involvement in most aspects of Egyptian's productive lives leads to my description of it as both omnipresent and inefficient.

The Egyptian state's current "omnipresent and inefficient" managerial approach is not historically unique. The historian Bernard Lewis similarly summarized the Abbasid's rule of Egypt over a thousand years ago as continuing "to be both ineffectual and oppressive" (Lewis 1970:181). The current state <u>is</u> ineffectual, though it is effective enough to hold its own.

In evolutionary terms, success is measured in the currency of survival (not in some constant ratio of "efficiency"), and the survival of the centralized Egyptian state reveals some small truths about the cultural evolutionary requirements of the Egyptian state and the Fayoum. The weakness of the currently omnipresent state gauges the equalization of pressures which centralized states face in becoming involved in local management issues.

Centralized states are concerned primarily with their own maintenance, not with the well being of those beneath it. Any hydraulic state over-extending itself by over-reaching its realm of influence and administration down to the minutia of the village level should be expected to fail (i.e. be "selected against"). Such structures would be as maladaptive in most circumstances. The level of bureaucracy which would develop in such circumstances would bind the state into a stagnant paralytic condition. Just as the Law of Evolutionary Potential teaches that over-specialization is evolutionarily dangerous, so too is the bureaucratic over-involvement in every aspect of life occurring within a state's domain (see Sahlins & Service 1960:97).[1]

There are uncountable instances of individuals behaving contrary to the dictates of the state (e.g. water theft), but even to the extent this occurs, the state still is the net beneficiary in these transactions (through the taxation of profits). In the instances I recorded of individuals violating irrigation and agricultural laws, the victims of their actions were most often their fellow peasant farmers, not the state.[2]

Theoretical Issues Addressed by the Fayoum Case

Issues of Infrastructure and Hydraulic States

My examination of the Fayoum's hydraulic evolution adds to our understanding of this specific region, but it also contributes to our larger theoretical understanding of hydraulic societies and the role of irrigation in cultural evolution. In the past few decades, Anthropologists, archaeologists and other social theorists examining questions of centralized hydraulic states have--for the most part--rejected despotic models derivative of Wittfogel. When looking at hydroagricultural societies these analysts have (wrongly) rejected hydraulic models for the absence of despotism. Similarly, when looking at hydraulic societies they have (unfairly) rejected hydraulic models because local administrators are seen to have some power over local irrigation matters. I have tried to clarify that these sorts of rejections are based more on caricatures of Wittfogel's writings than on his actual work. Caricatures that lead one to ridiculously expect dark shadowy hydraulic lords enslaving limping peasant automatons throughout the countryside, never allowing them a solitary moment of non-irrigation related life.

Unfortunately Wittfogel did much to further muddle this confusion. His "comparative study of total power"[3] wanders through history looking for examples that would assist him in his crudely veiled personal crusade against Marxist-Leninism. Wittfogel does his own argument a disservice by confusing state access to and reliance on terror and totalitarianism with the Asiatic Mode of Production.

Yet, despite Wittfogel's excesses in the dramatic, a thorough reading of his work should preclude these most common of misrepresentations. Despite its other shortcomings, Wittfogel's work clarifies the role of centralized states in the rise of riverine cultures; in coordinating massive irrigation works; and further clarifies the powers which states derive from such central control. It seems hard to deny (though many have) the simple observation that in the paths of cultural evolution throughout the world, "Large-scale control of irrigation and drainage in the big river valleys led to the hypertrophy of agro-managerial functions" (Harris 1979:104).

My view of the Fayoum's hydrology finds a long history of centralist state control over irrigation works. Though many features responsible for Egypt and the Fayoum's development are historically particularistic, there are over-riding nomothetic principles which governed the hydro-evolution of Egypt and the Fayoum.

These principles involve the relationship of demography, technology, environment and economy in determining the nature of cultural systems. Specifically in the case of the Fayoum, the environment and available technology have necessitated some level of centralized supervision and control _if_ significant agricultural returns are going to be achieved. This "_if_" is an important qualifier for its use recognizes the prime productive motivation of managerial states. Of course states and individuals (hypothetically) _could_ ignore these relationships of productivity, but every contingency governing the power of these states favors the desire for significant agricultural returns.

The Fayoum's hydraulic evolution cannot simply be accounted for by ecological or technological determinism. The peculiarities of the Fayoum's environment as well as the available hydraulic managerial technology does not simply determine the nature of its hydraulic administration. If ecological and technological features alone determined the Fayoum's hydraulic productivity then the successes of the early Ptolemaic and early Roman periods would have continued for thousands of years. But this certainly is not the case.

The reasons why every post-Ptolemaic administration has not highly maintained the Fayoum's irrigation system, has more to do with the economic conditions of the given period than with environmental or technological factors (which changed little from the 3rd century B.C. to the 19th century A.D.). The initial administrators of the foreign based Ptolemaic and Roman empires calculated that investments in Fayoumi irrigation would relinquish significant export grains, and having the available labor and funds they undertook such work. Perhaps these administrations (and others that followed) did not fully realize the continued maintenance costs such an approach would entail. Whatever their expectations, the costs were higher than they were willing to invest, so the processes of decay and collapse were inevitable.

Similarly, demographic and economic conditions best explain why every Post-Ptolemaic administration has bothered--to one degree or another--to rebuild Fayoumi irrigation works neglected by their predecessors. The cycles of Dynastic demographic collapse outlined in the second chapter certainly had their Fayoumi corollaries during the ages which followed. As irrigation works deteriorated, available farmland was reduced, thus increasing population pressure. There is plenty of evidence for increased demographic pressure following the neglect of Fayoumi hydraulic works during various periods: great reductions of habitable lands, farmers fleeing to Upper Egypt and the swamps of the Delta, entire villages being abandoned, etc. Such pressures eventually led to varying degrees of hydraulic reconstruction and reconditioning, though more often than not these took the form of a "quick fix".

Issues of Technology and Maintenance

One key to understanding historical fluctuations in the Fayoum's irrigation system is the degree to which agricultural intensifications did or did not coincide with technological upkeep. It was often during periods of increased taxation in the Fayoum that the processes of irrigation infrastructure deterioration accelerated.

In terms of behavioral consequences, increased tax demands required that citizens either sacrifice income or intensify production. Historically, most Fayoumi farmers have not had extra crops or incomes they could even consider sacrificing. When already marginalized Fayoumi populations faced increased taxes there was no option to sacrifice, so intensification was selected (or more accurately, attempted). In some sense, these hard times begot more hard times as intensification further degraded whatever condition of balance the system was approaching. The option of intensification with canal systems sadly in need of hydraulic maintenance and repairs understandably led to disastrous results. As Harris warns,

> Regardless of its immediate cause, intensification is always counter productive. In the absence of technological change, it leads inevitably to the depletion of the environment and the lowering of the efficiency of production since the increased effort sooner or later must be applied to more remote, less reliable, and less bountiful animals, plants, soils,

> minerals, and sources of energy. (Harris 1977:5 emphasis added)

In the Fayoum these attempts at intensification meant that those who first came into contact with the precious irrigation water were likely to take more than their fare share. When these behaviors were coupled with the lack of technological change, disaster followed. In the Fayoum this "absence of technological change" simply took the form of not maintaining or repairing irrigation canals, gates, weirs, lifting devices and drainage systems. The state's taxation demands prodded Fayoumi farmers into degrading their own hydraulic lifeline. Even during times without increased taxation demands, intensification without the technological change of hydraulic maintenance has led to disastrous results.

There are theoretical generalizations about technology to be gleaned from the Fayoum case. Primarily these relate to principles of the cultural selection of technologies. Technologies are selected or avoided primarily on the bases of costs and overall efficiencies of returns. Overall, technology must be cost effective, not simply feasible. The history of the Fayoum's agricultural management, highlights the high costs of maintenance and demonstrates that the "feasibility" of the irrigation technology is determined by the degree of centralized control and upkeep a regime invests.

When state structures fail to manage cumbersome irrigation technologies, these failures are infrastructural failures. Irrigation failure is technological failure despite the proximate roles played by cultural actors and administrative structures. The decisions to maintain or not maintain are made by cultural actors, but the demands of these systems are infrastructural demands. Expensive technologies (in this case those requiring high maintenance) can have expensive energetic demands on those who use them. If these demands cannot be met, technological failure occurs. Clearly these demands have been met most efficiently during times of centralized management.

The contingencies directing hydraulic maintenance are economic contingencies originating beyond the local scene (see MacKenzie 1985; Skinner 1981 & 1986). The Fayoum's agricultural existence depends on a supra-local recognition that certain remote events (up-canal water sharing and regulation, maintenance etc.) must occur. Morton Fried recognized that besides the control of large bodies of labor, hydraulic societies must rely on, "irrigation and drainage works [which] extend beyond and cross-cut small-scale interests so that nothing less than a community or several communities, is involved" (Fried 1967:209). This describes the Fayoum to the extreme. In order to maintain any reasonable level of agricultural productivity, the Fayoum needs the state (though the degree to which the state needs the Fayoum's is another issue entirely and has been temporally unstable).

It is hard to envision an organizational structure other than the state which could accomplish the coordination of hydraulic resources over such a large area. I would not say that such a structure could not exist, only that it has not evolved to date (or is absent from the ethnographic record). Without a state directing such actions, the localized motivations of community members hundreds of kilometers up-canal would not be in the best interests of Fayoumi irrigation.

It is unlikely that if individual villages along the Nile, the Ibrahimia canal, the Bahr Yusef and all the minor canals of the Fayoum were left to implement their own maintenance regimes, that they would work on activities beyond the most local in nature. As found in the more micro-setting within Fayoumi irrigation groups: the needs of downstream communities are of little concern or consequence in such a setting. In terms of "optimization" of effort, there would be no reason to engage in activities which would not benefit oneself, or one's own community. In this sense, the state is a coercive force which pushes communities to look beyond their own best interests.

I do not suggest that the state is a benevolent guide somehow watching out for the best interests of its citizens, on the contrary, if anything, the state is watching out for its own best interests. "Optimization" and human rights do not necessarily have anything to do with each other (see White 1975). Indeed, it is tempting to characterize many of Egypt's more centralist--and agriculturally successful--administrations (various Dynasties, early Ptolemaic, Muhammad 'Ali etc.) as "fascistic", but the lack of strong nationalist movements makes such classifications inaccurate.

Issues of Conveyance Loss

Most of the anthropological analyses of hydraulic and hydroagricultural societies have concentrated on the larger issues of state development and maintenance of power. For the most part these arguments have glossed over issues vital to the particular forms of non-despotic irrigation societies that evolved despite their hydraulic infrastructural base. One such vital issue is that of conveyance loss.

All cultures reliant on gravity-fed irrigation develop some method of regulating the operation and maintenance of their irrigation system. They also must evolve some method of counteracting violations of the irrigation rules governing their system. In the Fayoum, the Egyptian state is ultimately responsible for the operation and maintenance of irrigation works and the enforcement of irrigation laws. Different degrees of power are found at local and governorate levels, but irrigation is regulated in the last instance by the state. Just as there are relationships of power and productivity inherent in the material composition of any state-level irrigation system, there are also significant relationships that evolve at the local-level. In this macro sense, the changes in Fayoumi hydrology have been determined by new technologies, economics (ranging from funds available for maintenance to the state world economic markets), political upheavals, ecological shifts (i.e. Nile levels) and demographic pressures and the management and maintenance of existing irrigation works.

On a smaller, local scale are the relations concerning the particulars of an individual plot of land, such as soil quality, distance from water source, and drainage potential. These relationships, both large and small, in large part determine the social formation of the society that evolves through the success or failure of its agricultural system. We have seen that the Fayoum's particular ecological features led to the adoption of different forms of irrigation organization than elsewhere in Egypt. But on the smaller, local-scale, a particular irrigator's position within an irrigation network affects their abilities to manipulate the irrigation system.

This is not a predicament peculiar to the Fayoum. In gravity-fed systems around the world, irrigators closest to the water source have advantages over more distant ones. Simply put, more water is at their disposal. Their proximity to the irrigation source allows them a greater access to water than those located at a distance. There are both social and economic consequences to be derived from this relationship.

The cultural effects of conveyance loss clearly warrants further research. As discussed in chapter three, there is indirect evidence that conveyance loss effects the economic and social formations of cultures reliant on gravity-fed irrigation. With further field research into the significance of conveyance-loss more powerful cross-cultural models can be established.

The Egyptian State, The Fayoum and the Future

The Fayoum is caught in a classic "hydraulic trap" (see Harris 1977). There is little chance of the Fayoum becoming a self-managed region in the Near future (unless some unforseen disaster obliterated its current population levels). The Fayoum could not agriculturally function without the supra-regional control over irrigation works and water supplies.

The Egyptian state is centralized and omnipresent (in its own weak way) though not for hydraulic reasons alone. Beyond the state's hydraulic responsibilities, the Egyptian state is currently entrenched in the business of propping up the daily lives of most of its citizenry. Today, Egypt's once rural peoples are moving to cities such as Cairo at unmanageable rates (largely due to processes of land fractionalization). Most of these people enter the informal or private sectors, often squatting in home-made structures in alleys or building tops. Their ability to subsist is made possible by the state's subsidization of basic foodstuff prices. Laws are still in effect (from Nasser's time) guaranteeing jobs in a state agency for any college graduate, though the pay is less than families can subsist on. Even though Egypt is moving away from a strictly agricultural economy,

> About two-thirds of the nonagricultural workforce is on the state payroll. These gross figures do not include the armed forces (about 400,000) or the police (about 150,000). (Waterbury 1990:296)

As these legions "on the state payroll" increase at rapid rates, there is every reason to expect the efficiency of the state to decrease[4] (due to the inverted relationship between state size and efficiency--not size and strength).

Egypt's history demonstrates some differences in the implementation of management by regimes located within Egypt and those whose administrative center was elsewhere. Colonial administrators based within Egypt were more apt to reinvest revenues in the upkeep of Egyptian infrastructure. The periods where Egyptian managers were simply satisfying the demands of foreign Caliphates, Emperors, Prime Ministers and royalty show a greater neglect of irrigation works. Today, much the same pattern of neglect can be seen as Egyptian economic and managerial decisions are made only after consultation with the foreign powers seated in the United States Agency for International Development, the World Bank and the International Monetary Fund.

The state of the current state appears to be on shaky ground--though the academic prophets of Egyptian revolution have been incorrectly claiming for decades that an internal revolution was nigh. Unfortunately, one of the best proofs of the Egyptian state's vital role in managing Fayoumi irrigation will be found in the effects of a future governmental collapse and/or revolution. If and when the seemingly inevitable fundamentalist revolution topples the existing government for the sake of the Fayoum's Fellaheen they will need to maintain hydraulic control at least at the present levels, though the prognosis for this occurring is doubtful. The resulting "famine" is not the sort of evidence anyone would wish upon such a decent people, but if the apparent upheaval occurs, it will come nonetheless. Just as environments and technologies help create states, the neglect of these environments and technologies can likewise weaken them.

Whatever future political changes come in Egypt, its administrators will do well to recognize the Fayoum's high managerial requirements. As water shortages and water demands intensify to keep pace with Egypt's population explosion proper maintenance and increased conservation will increase in importance. Any administrator ignoring this will find himself in a dire predicament.

It seems inevitable that the future will bring more pumps to the Fayoum as a(n apparent) quick and easy solution to both water shortage problems and the present maintenance requirements. Of course an increased reliance on pumps would in the long run intensify both of these problems. If increased rates of pump use in the Fayoum leads to reduced maintenance (as it has along the Nile Valley and Delta) then it is easy to imagine levels of conveyance loss intensifying and down-canal communities facing conditions similar to these in the Medieval period. Likewise, if pumps are more widespread in the Fayoum, water waste will increase. One can easily imagine scenarios of run-away technology addiction where: as farmers increasingly come to rely on pumps the state neglects maintenance thus forcing more and more downstream irrigators to convert to pumps dependence.

If the reliance on pumps does increase in the Fayoum, it will be to meet short-term demands--as the long-term consequences are deleterious. As always, new technologies create short-term solutions but have long-term consequences which can not be foreseen by individuals using them. Though individuals tend to make short-term decisions, the selective features of evolution operate on both long- and short-term contingencies. If a technological adaptation (such as the pump) is in the long-term detrimental, yet has apparent short-term benefits it will be selected despite its eventual destructive nature. Technology is both a part of the cultural environment and a determinant of it, this creates the illusion that environmental problems can be easily solved by technological adjustments. But once a new technological approach is embraced, returning to the old methods is not an easy proposition.

> After a society has made its commitment to a particular technological and ecological strategy for solving the problem of declining efficiency, it may not be possible to do anything about the consequences of unintelligent choice for a long time to come. (Harris 1977:182)

But there is some hope of pump technology not dominating the Fayoum. Pumps are already available throughout the Fayoum, but farmers have not--for the most part--switched over to them. This is largely out of a recognition that the ancient saqqiya and gravity lift technologies are adequate (in terms of costs and benefits), as well as an overall inability to purchase pumps. There is some recognition that this old technology establishes an acceptable balance between the (maintenance) efforts of farmers and the hydraulic benefits. Though farmers will not most likely be weighing the oasis-wide effects of a possible switch to pumps, the adequate benefits of using the traditional water lifting technologies may be adequate to head off this potential disaster.

Notes

1. The Law of Evolutionary Potential maintains that: "The more specialized and adapted a form in a given evolutionary stage, the small is its potential for passing to the next stage" (Sahlins & Service 1960:97).

2. An exception to this assertion would be the farmers refusal to plant cotton at the State's insistence (though of course it could be argued that it not in the State's long-term interest to force farmers to ruin their lands by over cropping cotton).

3. The complete title of Wittfogel's magnum opus is : Oriental Despotism: A Comparative Study of Total Power.

4. The inefficiency of Egyptian bureaucratic workers was studied by Ayunbi, who dismally concluded that:

> On average, the Egyptian civil servant was estimated to "work" solidly only for a period of between twenty minutes and two hours every working day. (Ayunbi 1982:287 cf. Dumant 1973)

APPENDIX A
RAW DATA SET COLLECTED AND ANALYZED

001	01	58	19	2	2	20	03	020	3	3	6	76	0	0	19	KEMAN FARIS1
002	02	50	22	2	2	26	03	030	2	3	5	65	0	0	22	
003	03	44	19	2	2	11	17	060	1	3	4	57	1	0	19	
004	04	40	19	2	2	20	02	040	3	2	5	52	0	0	19	
005	05	44	18	2	2	21	02	080	2	2	4	57	0	0	18	
006	06	52	17	2	2	10	10	070	2	2	4	68	0	1	18	
007	07	38	15	2	2	08	01	100	2	3	5	50	1	0	17	
008	08	66	14	2	2	07	10	120	2	2	4	86	0	0	18	
009	09	47	12	2	2	11	02	120	1	2	3	61	0	1	15	
010	10	61	10	2	2	07	01	130	2	3	5	80	0	0	17	
011	11	48	09	2	2	11	25	130	1	1	2	63	0	0	16	
012	12	37	09	2	2	11	07	130	1	2	3	48	0	0	17	
013	13	28	10	2	2	07	02	150	2	2	4	36	0	0	15	
014	14	21	09	2	2	11	07	150	1	2	3	27	0	1		
015	15	39	10	2	2	11	12	170	1	1	2	51	0	0	16	
016	16	15	11	2	2	04	10	150	1	2	3	19	0	0	17	
017	17	44	10	2	2	07	02	180	2	2	4	57	0	0	15	
018	18	27	08	2	2	11	01	180	1	3	4	35	0	0		
019	19	18	09	2	2	11	02	180	1	2	3	23	0	1	14	

020	01	58	25	2	2	26	01	010	2	3	5	85	1	0	25	NAQALIFA1
021	02	49	23	2	2	20	02	010	3	2	5	72	0	0	23	
022	03	55	20	2	2	22	22	020	3	3	6	80	0	1	20	
023	04	60	18	2	2	22	22	010	3	3	6	88	1	0	19	
024	05	44	17	2	2	15	15	040	3	3	6	65	0	0	22	
025	06	40	20	2	2	26	03	040	2	3	5	58	0	0	20	
026	07	47	19	2	2	10	10	060	2	2	4	69	1	0	20	
027	08	50	16	2	2	11	08	050	1	2	3	73	0	0	18	
028	09	38	15	2	2	11	02	060	1	2	3	55	0	1	17	
029	10	45	10	2	2	16	16	070	3	3	6	66	1	0		
030	11	37	10	2	2	09	01	080	2	3	5	54	1	0	18	
031	12	37	09	2	2	09	01	080	2	3	5	54	0	1	15	
032	13	32	10	2	2	11	02	080	1	2	3	47	0	1	17	
033	14	29	10	2	2	07	18	090	2	1	3	42	0	0	19	
034	15	33	09	2	2	10	01	110	2	3	5	49	0	0	18	
035	16	28	08	2	2	25	02	120	1	2	3	41	0	0		
036	17	30	09	2	2	09	02	120	2	2	4	41	0	1		

037	01	42	24	2	2	22	22	005	3	3	6	40	0	0	24	NAQALIFA2
038	02	55	24	2	2	22	22	010	3	3	6	52	0	0	23	
039	03	52	23	2	2	20	01	020	3	3	6	50	0	0	22	
040	04	46	23	2	2	20	17	020	3	3	6	44	0	0	20	
041	05	62	20	2	2	22	22	030	3	3	6	60	0	0		

042	06	58	20	2	2	26	17	030	2	3	5	55	0	0	20	
043	07	52	20	2	2	21	01	040	2	3	5	50	0	0	19	
044	08	57	20	2	2	15	15	040	3	3	6	55	0	0		
045	09	48	17	2	2	11	01	060	1	3	4	46	0	0	19	
046	10	49	17	2	2	08	01	060	2	3	5	47	0	0	17	
047	11	26	16	2	2	10	02	060	3	2	5	25	0	1	17	
048	12	53	16	2	2	04	03	070	1	3	4	51	0	0	15	
049	13	47	18	2	2	11	06	070	1	2	3	45	0	0	17	
050	14	39	18	2	2	04	17	080	1	2	3	38	0	1		
051	15	35	16	2	2	26	09	080	2	2	4	34	0	0	15	
052	16	43	16	2	2	08	07	100	2	2	4	41	0	0	16	
053	17	37	15	2	2	11	21	100	1	2	3	36	0	0		
054	18	33	15	2	2	11	02	100	1	2	3	32	0	0		
055	19	25	13	2	2	11	25	110	1	1	2	24	0	1		
056	20	41	13	2	2	21	07	110	2	2	4	39	0	1	18	
057	21	28	12	2	2	21	06	120	2	2	4	27	0	0	17	
058	22	37	12	2	2	11	10	130	1	2	3	36	0	0		
059	23	19	10	2	2	11	21	130	1	2	3	18	0	1	17	
060	24	34	10	2	2	11	02	140	1	2	3	33	0	0	19	
061	25	18	11	2	2	26	02	150	2	2	4	17	0	1	18	
062	26	23	11	2	2	07	02	150	2	2	4	22	0	0	16	

063	01	39	23	2	2	07	01	010	2	3	5	57	0	0	23	KEMAN FARIS2
064	02	47	23	2	2	04	01	010	1	3	4	69	1	1	23	
065	03	44	22	2	2	22	22	030	3	3	6	65	0	0	22	
066	04	51	20	2	2	22	22	020	3	3	6	75	1	0	20	
067	05	43	19	2	2	22	22	030	3	3	6	63	1	0	19	
068	06	17	18	2	2	26	17	050	2	3	5	25	0	0	20	
069	07	40	16	2	2	26	01	050	2	3	5	59	0	0	19	
070	08	42	17	2	2	26	01	050	2	3	5	62	0	1	19	
071	09	36	15	2	2	26	17	070	2	3	5	53	0	0	19	
072	10	37	15	2	2	11	17	070	1	3	4	54	0	1	18	
073	11	29	15	2	2	11	01	080	1	3	4	43	0	1	19	
074	12	38	12	2	2	11	03	070	1	3	4	56	1	0	18	
075	13	19	16	2	2	11	03	080	1	3	4	28	0	0	17	
076	14	27	09	2	2	11	19	090	1	1	2	40	0	0	17	
077	15	31	12	2	2	11	07	100	1	2	3	46	0	0	18	
078	16	26	10	2	2	11	06	090	1	2	3	38	0	0	20	
079	17	22	07	2	2	11	01	100	1	3	4	32	0	0	19	

080	01	35	25	3	1	04	03	010	1	3	4	44	0	0	25	QASR AL-BASL1
081	02	31	24	3	1	04	03	010	1	3	4	26	0	0	24	
082	03	27	22	3	1	04	01	020	1	3	4	34	0	0	22	
083	04	22	22	3	1	11	01	030	1	3	4	28	0	0	22	
084	05	31	20	3	1	04	03	050	1	3	4	39	0	0	20	
085	06	21	16	3	1	03	17	050	3	3	6	26	0	0	16	
086	07	18	16	3	1	06	17	060	2	3	5	22	0	0	16	
087	08	24	15	3	1	11	07	060	1	2	3	30	1	0	15	
088	09	14	14	3	1	07	08	060	2	2	4	18	0	0	14	
089	10	28	13	3	1	04	01	070	1	3	4	35	0	0	13	
090	11	40	12	3	1	04	17	090	1	3	4	50	0	0	12	
091	12	17	11	3	1	11	02	090	1	2	3	21	0	0	11	

092	13	32	09	3	1	04	03	100	1	3	4	40	0	0	09	
093	14	27	08	3	1	11	03	110	1	3	4	34	0	0	08	
094	15	24	11	3	1	11	02	120	1	2	3	30	0	0	11	
095	16	27	10	3	1	11	17	120	1	2	3	34	0	0	10	
096	17	33	07	3	1	21	03	130	2	3	5	41	0	0	07	
097	18	28	09	3	1	07	17	140	2	3	5	35	0	0	09	
098	19	14	08	3	1	04	17	150	1	3	4	18	0	0	08	
099	20	32	05	3	1	11	02	160	1	2	3	40	0	0	05	
100	01	46	21	3	3	11	17	100	1	3	4	82	0	0	21	QASR AL-BASL2
101	02	31	20	3	3	07	02	100	2	2	4	55	1	0	20	
102	03	28	19	3	3	11	01	120	1	3	4	50	0	0	19	
103	04	42	19	3	3	07	01	130	2	3	5	75	0	0	19	
104	05	27	18	3	3	06	01	130	2	3	5	48	1	0	18	
105	06	36	19	3	3	12	01	140	1	3	4	64	0	0	19	
106	07	17	17	3	3	11	08	150	1	2	3	30	0	0	17	
107	08	46	16	3	3	11	17	150	1	3	4	82	0	0	16	
108	09	42	16	3	3	14	14	160	3	3	6	75	1	0	16	
109	10	24	15	3	3	11	17	180	1	3	4	43	0	0	15	
110	11	28	13	3	3	11	07	190	1	2	3	50	1	0	13	
111	12	49	12	3	3	11	02	200	1	2	3	88	0	0	12	
112	13	20	10	3	3	14	17	200	3	3	6	36	0	0	10	
113	14	26	10	3	3	11	03	220	1	3	4	46	0	0	10	
114	01	37	20	3	1	11	10	010	1	2	3	66	0	0	20	QASR AL-BASL3
115	02	39	19	3	1	19	02	010	1	2	3	70	0	0	19	
116	03	29	17	3	1	11	02	020	1	2	3	52	0	0	17	
117	04	40	15	3	1	11	06	020	1	2	3	71	0	0	15	
118	05	33	12	3	1	09	25	040	2	0	2	59	0	0	12	
119	06	38	10	3	1	11	01	040	1	3	4	68	0	0	10	
120	07	27	10	3	1	11	10	040	1	3	4	48	0	0	10	
121	08	26	10	3	1	04	10	050	1	2	3	46	1	0	10	
122	09	36	09	3	1	06	02	050	2	2	4	64	0	0	09	
123	10	22	10	3	1	11	25	050	1	0	1	39	0	0	10	
124	11	29	08	3	1	04	08	060	1	2	3	52	0	0	08	
125	12	38	07	3	1	11	07	060	1	2	3	67	0	0	07	
126	13	24	08	3	1	11	04	060	1	1	2	43	0	0	08	
127	14	27	07	3	1	07	25	080	2	0	2	48	0	0	07	
128	01	49	23	1	1	06	01	010	2	3	5	94	0	0	23	SHAKSHOUK
129	02	44	20	1	1	20	02	020	3	2	5	84	0	1	20	
130	03	52	18	1	1	08	02	020	2	2	4	99	0	0	18	
131	04	38	16	1	1	11	01	040	1	3	4	73	0	0	19	
132	05	40	14	1	1	11	01	050	1	3	4	77	0	0		
133	06	43	12	1	1	07	01	050	2	3	5	83	0	0	20	
134	07	32	11	1	1	18	01	050	1	3	4	62	0	0	19	
135	08	37	10	1	1	04	17	070	1	3	4	71	0	1	18	
136	09	25	09	1	1	11	08	080	1	2	3	48	0	0		
137	10	29	08	1	1	11	01	080	1	3	4	56	0	0	17	
138	11	31	06	1	1	10	02	090	2	2	4	60	0	0	17	
139	12	27	05	1	1	08	02	090	2	2	4	52	0	0	18	
140	13	29	06	1	1	11	02	100	1	2	3	56	0	0	18	

141	01	47	19	1	2	22	22	010	3	3	6	90	0	0	19	SANHOUR1
142	02	39	19	1	2	16	16	020	3	3	6	71	0	0	19	
143	03	37	18	1	2	23	23	040	3	3	6	31	1	0	18	
144	04	35	16	1	2	15	15	010	3	3	6	67	1	0	18	
145	05	28	14	1	2	15	15	020	3	3	6	54	0	0	18	
146	06	45	13	1	2	20	25	020	3	0	3	86	0	0		
147	07	49	11	1	2	26	01	030	2	3	5	94	0	0	18	
148	08	26	19	1	2	11	01	040	1	3	4	50	0	1	17	
149	09	34	06	1	2	11	02	030	1	2	3	65	0	0	14	
150	10	39	06	1	2	08	01	040	2	3	5	75	1	0		
151	11	25	06	1	2	26	18	060	2	1	3	48	0	0	16	
152	12	21	04	1	2	06	01	070	2	3	5	40	0	0	17	
153	13	23	03	1	2	11	02	080	1	3	4	44	1	0	15	

154	01	39	20	4	3	20	01	010	3	2	5	75	0	0	20	SANHOUR2
155	02	28	22	4	3	20	03	010	3	3	6	54	0	0	22	
156	03	42	19	4	3	08	17	020	2	3	5	81	0	0	19	
157	04	48	17	4	3	11	17	030	1	3	4	92	0	0	19	
158	05	43	15	4	3	11	01	030	1	3	4	83	0	0	20	
158	06	44	17	4	3	06	01	040	2	3	5	84	0	1	18	
159	07	49	13	4	3	10	17	050	2	3	5	75	0	0	18	
160	08	43	11	4	3	26	03	050	2	3	5	83	0	0	16	
161	09	44	10	4	3	11	08	050	1	2	3	84	0	0	18	
162	10	37	12	4	3	11	07	060	1	2	3	71	0	1	17	
163	11	39	08	4	3	11	06	070	1	2	3	75	0	1	15	
164	12	33	06	4	3	11	25	070	1	0	1	52	0	0	12	
165	13	27	04	4	3	11	01	080	1	3	4	52	0	0	15	

COLUMN	TRAIT	DESCRIPTION
01-3	ID	(ID Number)
05-6	RANK	(Rank Distance in Irrigation System)
08-9	POWER	(Raw Freeman Power Score)
11-12	LPS	(Raw Liters Per Second)
14	DEVICE	(1=Saqqiya, 2=undershot, 3=pump, 4=gravity)
16	ELEV	(Elevation Class)
18-19	WCROPS	(Winter Crops)
21-22	SCROPS	(Summer Crops)
24-26	DIST	(Distance)
28	WWS	(Winter Wheat Score)
30	SWS	(Summer Wheat Score)
32	TWS	(Total Wheat Score)
34-35	PAPS	(Power As Percent Score)
37	MECCA	(Was owner a Haj? 0=no, 1=yes)
39	THEFT	(Theft Observed? 0=no, 1=yes)
41-42	MAGRUR	(LPS with Magrur Time calculation)

APPENDIX B
POWER SCORE MATRIX

"RANKEES"

		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
	01	3	2	2	4	2	3	2	3	2	4	2	2	1	1	2	1	3	0	0
	02	3	3	2	2	3	4	2	4	3	3	3	3	2	2	2	0	2	2	2
	03	4	2	2	1	0	4	3	4	3	4	4	2	0	2	3	1	4	1	0
	04	3	4	2	1	3	2	2	4	2	2	2	1	2	1	4	0	4	0	1
"	05	3	3	3	2	4	3	1	4	2	4	3	2	1	1	3	1	2	2	0
R	06	3	1	1	1	3	2	2	4	3	2	2	0	2	0	2	0	0	0	2
A	07	2	2	2	2	2	2	2	4	4	3	1	0	1	1	0	1	1	0	3
N	08	4	3	2	3	3	4	2	4	2	3	3	1	0	2	4	2	3	3	0
E	09	2	1	1	1	2	3	3	3	3	4	4	2	2	2	2	0	0	0	2
R	10	3	2	3	2	3	4	2	4	3	2	1	3	1	0	3	0	4	2	0
S	11	4	3	1	3	2	2	1	3	2	3	2	1	2	2	0	1	1	0	0
"	12	2	3	2	2	2	1	1	4	3	3	1	2	3	0	1	1	3	2	2
	13	3	1	3	3	1	2	2	3	2	2	0	3	0	1	3	3	0	1	0
	14	2	2	4	2	2	3	1	4	2	4	3	1	0	0	0	2	2	3	1
	15	3	3	3	1	1	3	3	3	3	3	4	2	2	1	2	0	1	0	0
	16	3	3	2	4	2	1	2	4	2	4	2	3	0	0	0	1	3	3	3
	17	4	4	4	2	3	4	2	4	3	4	4	4	4	2	2	0	4	3	1
	18	4	4	2	2	2	2	2	3	0	3	4	2	3	2	3	0	3	2	0
	19	3	4	3	2	4	3	3	4	3	4	3	3	2	1	3	1	4	3	1

ABOVE: KE1 Group Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
01	2	1	3	2	2	1	2	2	2	1	2	2	2	4	3	3	2
02	3	4	3	3	3	0	2	3	1	2	1	3	1	3	4	2	2
03	2	3	4	3	3	1	3	2	3	2	1	2	2	1	3	3	3
04	4	2	3	4	2	2	3	2	1	2	2	0	0	0	2	2	1
05	2	3	3	3	2	1	3	2	3	4	2	3	1	2	0	2	1
06	2	3	2	3	2	0	2	3	2	2	1	2	0	3	4	2	2
07	1	3	1	3	1	1	1	2	1	0	0	3	2	1	1	1	2
08	2	2	0	4	2	0	3	0	2	2	2	4	1	2	2	0	1
09	2	2	2	2	2	2	2	2	2	2	3	3	2	2	0	0	0
10	3	2	1	4	2	1	2	2	2	2	2	1	0	2	3	2	1
11	0	2	3	3	3	1	3	3	3	3	2	3	2	2	1	2	1
12	2	3	4	2	1	0	0	3	1	1	0	2	0	0	1	0	1
13	2	4	2	3	3	1	2	2	1	2	2	3	2	1	2	1	1
14	3	2	2	2	4	1	3	4	2	3	1	0	0	0	0	2	1

15	2	4	3	3	2	0	2	3	3	2	2	2	1	0	2	2	1
16	3	3	4	3	4	2	3	3	3	4	3	3	2	2	2	2	1
17	4	4	4	4	3	3	4	4	4	3	3	2	1	2	0	0	1

ABOVE: KE2 Group Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
01	3	2	4	4	3	2	3	2	1	2	2	2	1	1	1	0	2
02	4	3	3	4	2	2	4	4	3	3	3	3	0	1	1	2	0
03	4	4	4	3	2	1	4	3	2	3	4	3	2	2	2	1	1
04	3	2	4	4	4	4	4	4	4	1	1	0	4	3	2	2	2
05	3	3	3	4	2	2	0	2	2	4	0	2	3	2	3	0	0
06	3	4	2	3	1	1	2	2	3	2	3	3	4	2	2	2	2
07	3	2	3	4	2	1	0	2	2	3	2	4	3	2	3	3	2
08	3	2	2	4	4	3	2	3	2	4	4	3	2	0	3	2	2
09	4	2	2	2	2	2	4	2	2	2	2	2	0	3	0	1	0
10	3	3	4	3	1	3	4	3	2	2	2	3	4	2	3	2	3
11	3	2	4	4	2	2	3	2	0	4	3	2	2	1	3	4	4
12	4	3	3	3	3	0	0	4	3	2	0	0	3	2	2	3	2
13	3	3	3	2	3	2	3	2	2	0	3	2	2	0	3	2	0
14	3	3	4	4	4	4	4	4	3	3	2	0	0	2	1	0	4
15	4	4	2	4	2	3	3	3	1	3	0	3	1	3	2	2	3
16	4	3	4	4	4	4	3	4	3	4	4	3	0	1	0	2	2
17	4	4	4	4	3	4	4	4	3	3	2	2	1	2	2	0	1

ABOVE: NAQ1 Group Power Score Matrix

	1	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
01	2	1	1	1	1	1	1	0	0	1	2	1	2	1	1	2	2	2	1	2
02	2	2	1	1	2	1	0	2	0	0	3	0	0	0	1	1	1	2	0	1
03	2	0	2	1	1	1	2	0	1	1	2	1	2	3	1	2	0	1	0	0
04	0	2	2	3	2	1	0	1	0	0	0	0	2	0	2	0	2	0	1	2
05	2	0	2	1	2	1	1	1	0	2	2	1	2	0	1	3	2	1	1	2
06	2	2	3	1	1	2	1	1	1	3	3	2	0	2	1	2	2	2	0	0
07	3	1	0	2	1	1	0	2	0	1	0	0	3	2	2	1	1	2	1	1
08	2	2	1	1	2	1	1	2	0	1	2	2	2	1	1	1	0	0	1	3
09	3	2	2	1	0	1	2	2	1	0	2	3	0	0	1	2	2	1	1	2
10	1	1	3	1	2	1	1	0	1	1	3	0	2	2	2	3	1	2	0	1
11	2	2	2	0	0	1	1	2	0	2	3	1	1	1	1	2	1	2	1	1
12	1	0	2	1	1	1	1	1	1	3	1	0	3	2	1	1	2	2	1	2
13	0	0	0	1	2	1	0	1	2	3	1	0	3	2	3	1	3	0	1	2
14	2	2	1	1	3	1	2	0	0	1	3	1	2	0	1	1	2	1	1	2
15	3	0	0	1	2	1	1	1	1	0	2	1	1	0	2	2	1	2	0	2
16	2	2	2	1	2	1	0	2	2	1	4	1	2	3	1	2	1	1	1	1
17	3	1	0	1	1	1	2	2	0	2	2	0	0	2	2	3	2	2	1	2
18	1	0	1	1	2	1	1	0	3	2	0	2	1	2	1	1	2	2	1	2
19	0	0	0	1	0	1	1	1	1	2	2	0	3	1	1	2	0	2	0	2
20	2	1	2	1	2	1	0	3	0	2	3	1	1	0	1	1	1	1	1	2

ABOVE: Q1 Group Power Scorce Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13	14
01	3	4	2	3	2	4	1	3	2	1	3	3	1	1
02	3	2	2	2	1	2	2	4	4	2	2	4	2	2
03	3	2	2	4	2	3	1	3	4	2	2	4	1	2
04	4	3	2	4	2	1	1	4	3	1	2	2	2	3
05	4	1	2	4	2	2	1	2	4	2	3	4	1	1
06	4	2	2	2	3	4	2	4	3	1	2	4	1	2
07	3	2	2	3	1	2	1	4	2	1	2	4	1	3
08	3	1	3	2	4	3	1	2	2	2	1	4	1	2
09	3	2	2	3	2	2	1	2	1	1	1	2	1	1
10	3	3	2	3	1	2	2	4	4	3	2	4	2	2
11	3	2	1	4	1	1	1	4	2	2	3	2	1	1
12	3	2	2	2	1	2	1	3	4	3	2	4	1	2
13	4	3	2	3	2	4	1	3	3	1	2	4	3	2
14	3	2	2	3	3	4	1	4	4	2	1	4	2	2

ABOVE: Q2 Group POwer Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13	14
01	3	3	2	3	2	3	2	2	3	2	2	2	1	2
02	2	3	2	4	3	4	2	2	2	1	2	2	2	1
03	2	3	2	3	2	2	3	2	2	1	2	3	2	2
04	3	2	3	4	3	3	1	2	2	1	2	3	2	0
05	4	3	4	4	2	3	4	2	3	3	4	2	3	4
06	2	4	1	3	3	4	2	1	3	1	2	2	1	2
07	3	2	2	2	2	2	2	3	3	1	2	4	2	3
08	2	3	2	2	3	3	2	2	3	1	2	3	1	2
09	2	0	1	2	2	1	0	1	2	1	2	3	1	0
10	2	3	1	3	3	3	2	1	2	2	2	2	1	2
11	3	2	2	4	2	2	1	2	3	1	1	3	1	3
12	2	4	2	2	2	2	3	1	2	2	2	3	3	1
13	4	3	3	2	2	3	1	2	3	2	2	3	2	2
14	3	4	2	2	2	3	2	3	3	3	2	3	2	3

ABOVE: Q3 Group Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13
01	3	3	4	2	3	4	3	3	2	3	2	2	2
02	3	3	4	3	2	3	2	2	2	2	2	2	2
03	4	4	4	2	4	4	3	4	2	2	2	3	3
04	3	4	4	2	2	3	2	3	2	3	4	2	3
05	4	3	4	4	3	4	3	2	1	3	3	3	3
06	4	3	4	3	3	0	2	2	2	2	3	2	2
07	4	2	4	2	3	4	2	3	3	0	3	2	3
08	4	3	4	3	3	4	2	2	2	1	3	2	2
09	4	4	4	2	4	3	3	3	1	3	2	3	2
10	4	3	4	4	4	3	4	2	2	2	3	2	3
11	4	4	4	4	4	4	2	4	2	2	0	2	2
12	4	4	4	3	2	3	2	4	2	3	2	1	1
13	4	4	4	4	3	4	2	3	2	3	2	1	1

ABOVE: SHAK Group Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13
01	4	3	0	4	2	4	4	2	3	4	2	2	2
02	3	4	4	4	3	4	4	2	4	4	3	0	4
03	4	4	3	4	4	2	4	2	4	4	4	3	2
04	3	2	4	4	2	4	4	2	3	3	1	1	2
05	3	3	3	4	0	4	4	2	3	3	2	2	1
06	4	3	3	4	0	4	4	2	3	0	0	1	1
07	4	3	4	4	3	4	2	2	4	4	3	1	1
08	3	4	2	4	1	2	4	2	4	4	2	3	1
09	4	3	3	4	2	2	4	2	1	3	3	3	3
10	4	4	3	4	3	3	4	2	3	1	1	0	1
11	3	0	4	4	4	4	4	2	2	3	2	2	2
12	4	2	2	4	2	4	3	2	4	4	0	1	0
13	4	4	2	4	2	4	4	2	2	2	2	2	1

ABOVE: SAN1 Group Raw Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13
01	3	1	4	3	2	4	4	2	4	2	3	3	2
02	4	3	4	4	4	3	3	3	3	3	3	2	3
03	2	1	2	4	3	5	2	3	4	4	4	2	2
04	4	2	3	3	3	4	3	4	4	3	3	3	2
05	2	4	4	4	3	1	4	3	3	3	2	4	3
06	3	3	4	4	4	4	2	4	4	2	2	2	2
07	3	3	2	3	3	3	4	4	4	3	3	4	3
08	3	1	3	4	4	4	3	3	3	3	3	2	2
09	3	2	3	3	3	4	3	4	2	4	4	3	1
10	4	3	2	4	4	3	4	3	2	3	3	3	2
11	3	0	4	4	3	3	2	3	4	2	2	2	1
12	3	3	3	4	4	4	3	3	4	2	4	1	2
13	2	2	4	4	3	2	2	4	3	3	3	2	2

ABOVE: SAN2 Group Raw Power Score Matrix

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
01	2	2	3	2	2	3	2	1	2	2	1	3	2	2	2	2	1	2	3	2	0	1	1	2	1	2
02	3	3	1	2	0	0	3	3	2	3	2	3	1	2	2	4	1	2	0	0	1	1	1	1	0	1
03	3	3	3	3	3	4	2	2	3	2	3	2	2	3	3	2	0	1	1	1	2	2	0	2	0	0
04	2	2	2	1	3	3	2	2	2	4	0	2	2	2	2	3	1	0	0	0	1	1	1	2	0	0
05	2	3	3	1	2	2	2	2	3	2	1	1	1	2	3	1	0	2	1	2	3	2	0	3	1	0
06	1	3	2	2	3	2	2	1	1	1	0	2	3	1	0	0	0	1	0	3	0	2	1	0	1	0
07	2	3	1	1	3	2	2	3	2	2	1	3	2	1	2	2	2	0	1	0	1	1	1	2	0	0
08	1	2	1	2	1	2	3	2	2	3	2	0	0	0	2	1	1	2	1	2	2	2	2	3	0	2
09	1	3	1	1	3	2	2	2	3	1	0	2	2	1	3	2	2	0	0	0	1	0	1	2	0	0
10	1	2	2	1	3	2	0	2	2	3	1	3	1	1	2	0	1	3	2	3	2	2	0	1	1	1
11	2	1	2	2	1	1	2	2	2	2	1	1	2	1	0	4	3	0	0	1	1	0	1	2	0	0
12	2	2	1	1	2	1	3	3	1	0	1	3	0	2	1	2	1	2	1	1	2	1	2	2	1	2
13	1	1	2	1	3	2	2	2	2	2	1	4	2	1	1	1	2	1	0	2	0	3	1	0	0	2
14	2	0	1	2	0	1	2	2	2	1	2	2	3	1	2	0	2	1	0	3	1	2	0	1	2	1
15	0	1	2	1	2	2	2	3	0	0	0	1	1	0	0	1	1	3	1	2	2	0	0	1	0	0
16	1	2	1	2	3	2	0	3	1	2	0	1	2	1	1	2	2	1	0	2	2	1	1	0	1	1
17	1	1	2	1	3	2	2	2	1	1	0	1	1	2	0	0	1	2	0	3	0	2	2	2	1	1

18	2	1	2	2	4	4	1	3	2	2	2	2	2	1	1	1	2	0	3	2	1	3	0	0	1	0
19	2	2	1	1	2	3	2	1	1	3	1	2	2	1	2	1	2	1	2	1	2	1	0	0	1	1
20	1	4	2	2	2	2	2	2	2	2	0	0	1	2	0	2	2	2	0	1	0	0	1	1	0	0
21	1	2	2	2	0	0	1	1	1	3	1	2	2	0	1	0	1	0	1	2	1	1	0	2	1	1
22	2	0	3	2	4	3	3	2	2	2	1	1	2	2	2	1	0	2	2	0	2	2	0	0	0	0
23	2	2	2	2	2	3	2	3	1	0	0	2	3	2	3	3	2	1	3	3	0	2	1	2	2	2
24	1	3	3	3	4	4	3	4	3	3	2	3	2	3	2	2	2	2	1	2	1	4	0	1	0	2
25	2	3	4	3	4	3	3	3	3	1	1	4	3	2	0	2	3	0	2	2	0	2	2	1	2	2
26	2	4	3	3	3	3	2	1	2	2	2	3	3	3	2	4	2	2	0	2	0	1	0	3	1	1

ABOVE: NAQ2 Group Raw Power Score Matrix

Horizontal axis is ranked by vertical axis (this means that the vertical irrigators ranked the power of all the horizontal irrigators).

REFERENCES

Abbott, N.
1937 The Monasteries of the Fayoum. Studies in Ancient Oriental Civilization 16. Chicago: University of Chicago Press.

Abdalla, A.
1988 "The Armed Forces and the Democratic Process in Egypt" Third World 10(4):1452-1466.

Abd al Hakim, Muhammad Subhi
1953 Sukkan Mudiriyyat al-Fayyum. Unpublished MA Thesis Cairo University, 2 Volumes.

Abd al-Ghani, M. M.
1985 "Comparative Study on the Vegetation of the Bahariya and Farafra Oasis and the Faiyum Region" Ph D. Dissertation, University of Cairo.

Abd al-Rahim, A.
1984 "Land Tenure in Egypt and Its Social Effects on Egyptian Society: 1789-1813" In Land Tenure and Social Transformation in the Middle East. T. Khalidid, ed. Pp. 237-248. Beirut: American University Beirut Press.

Abdel-Fadil, Mahmoud
1975 Development, Income Distribution and Social Change in Rural Egypt, 1952-1970. Cambridge: Cambridge University Press.

Abdel-Malek, Anouar
1962 Egypt: Military Society, the Army Regime, the Left and Social Change Under Nasser. New York: Vintage Books.

Abdou, Dyaa K., B. D. Gardner & Richard Green
1983 The Economic Implications of Enforcing Agricultural Laws in Egypt Agricultural Development Systems Project Economic Working Paper No. 144. Cairo, Egypt.

1986 "To Violate or Not Violate the Law: An Example from Egyptian Agriculture" American Journal of Agricultural Economics 68(1):120-126.

Abdu al Hakem, M.
1954 Sakan madinah al Fayoum. Cairo: Darasat d'au geographia.

Abrahamian, Ervand
1974 "Oriental Despotism: The Case of Qajar Iran" International Journal of Middle Eastern Studies 5:3-31.

1975 "European Feudalism and Middle Eastern Despotism" Science and Society 34(2)129-156.

Abu al-izz, M. S.
1971 Landforms of Egypt. (Translated by Yusuf A. Fayid) Cairo: American University Cairo Press.

Abu-Lughod, Lila
1986 Veiled Sentiments: Honor and Poetry in a Bedouin Society. Berkeley: University of California Press.

1989 "Zones of Theory in the Anthropology of the Arab World" Annual Review of Anthropology 18:267-306.

Abu Salih, S.
1969 The Churches and Monasteries of Egypt and Some Neighboring Countries. Oxford: Clarendon Press.

Adams, Richard
1986 Development and Social Change in Rural Egypt. Syracuse, New York: Syracuse University Press.

Adams, Robert Mc C.
1966 The Evolution of Urban Society. Chicago: Aldine.

Adams, Robert Mc C. & Hans J. Nissen
1972 The Uruk Countryside: The Natural Setting of Urban Societies. Chicago: University of Chicago Press.

Agrar und Hydrotechnik GMBH
1982 "Fayoum Agricultural Development Project Feasibility Study" 3 Volumes, Cairo: United States Agency for International Development.

Ahmed, Akbar S.
1992 Postmodernism and Islam. London: Routledge.

Aikman, David
1991 "Egypt: A Dangerous Confession" Christianity Today April 8, Pp. 57.

Allan, J. A.
1983 "Some Phases in Extending the Cultivated Area in the Nineteenth and Twentieth Century in Egypt" Middle Eastern Studies 19(4):470-481.

Allam, S.
1990 "Women as Holders of Rights in Ancient Egypt" Journal of the Economic and Social History of the Orient 33(1):1-34.

Allen, Marti Lu
1982 "A Stylistic, Iconographical, and Technical Examination of Terra Cotta Figurines Excavated in the Fayoum" American Research Center in Egypt Newsletter 118(1):24-27.

Amelineau, E.
1890 La geographie de l'Egypte a l'epoque Copte. Paris: ATL

Amer, Ibrahim
1958 Al-Ardh wa al-Fallah: Al-Mas'lah al-Zira'iyya fi Misr. Cairo: Dar al-Misriyya.

Anderson, Perry
1974 Lineages of the Absolutist State. London: NLB.

Ansari, Hamied
1986 Egypt: The Stalled Society. Albany, New York: SUNY Press.

Anti, C.
1931 "Gli scavi della Missione archeologica italiana a Umm el Breighat" Aegyptus XI:389-391.

Apostolides, B.
1967 "Etude sur la topographie du Fayoum" Bulletin Societe Arche d' Alexandria No. 9.

Arab Republic of Egypt
1989 Statistical Year Book 1952-1988. Cairo: Central Agency for Public Mobilization and Statistics.

Arabic-Polish Anthropological Expedition
1962 Publications of the Second Arabic-Polish Anthropological Expedition: Part III, Anthropological Measurements of Population in the U.A.R. (Egypt-Fayoum, Beheira). Warsaw: Polish Academy of Sciences.

Arjona, Marta
1978 The National Museum of Cuba, Painting: The Fayum Portrait. Havana: Museo Nacional de Cuba.

Armayor, O. Kimball
1985 Herodotus Autopsy of the Fayoum. Amsterdam: J. C. Gieben.

Arnold, Dieter Un Dorthea
1979 Der Tempel Qasr el-Sagha. Kairo: Deutsches Archaologisches Institut.

Atkinson, J. D.
1934 Handbook of Egyptian Irrigation. Cairo: Government Press.

Audebeau, Charles
1930 "La Legende du Lac Moeris" Bulletin de l'Institut d'Egypte 11:37-52.

Ayalon, D.
1956 Gunpowder and Firearms in the Mamluk Kingdom. London: Mitchell Vallentine.

Ayrout, Henry
1952 Fellahs d'Egypte. Cairo: Sphynx.

Azadian, M. & Georges Hug
1928 "Les Sources du Fayoum" Bulletin de la Societe Royale de Geographie d'Egypte tome XVI & XVII.

1930 "Les sources du Wady el-Rayan" Bulletin de la Societe Royale de Geographie d'Egypte XVIL (3):145-158.

1931 "Etudes sur la salinite du Lac Quaroun" Bulletin de la Societe Royale de Geographie d'Egypte tome XVIII:225-250.

1932 "Notes sur le Ouady Mouellah" Bulletin de la Societe Royale de Geographie d'Egypte tome XVII:47-63.

Aziz, Fouad
1987 "Irrigation in Egypt from Saad el-kafra (2650 B.C.) to Saad el Aali (1664 A.D.)" Unpublished Manuscript in Soliman Huzayyin Collection of Geographical Society of Egypt, Cairo.

Bachatly, Charles Alexandre
1937 "Gisements capsiens au nord du Fayoum" Bulletin de l'Institut d'Egypte 19:117-122.

1951 "Note complementaire a propos des gisements capsiens aunord Fayouum" Bulletin de l'Institut d'Egypte 32:287-290.

Badr, Mahmoud, James Seale & Abdel Asim Mostafa
1982 "Small Scale Enterprise in Egypt: Fayoum and Kalyubiya Governorates, Phase One Survey Results" HSU Rural Development Series Working Paper No. 23. Cairo: HSU.

Baer, G.
1962 A History of Landownership in Modern Egypt. London: Oxford University Press.

Baer, Hans
1987 "Nineteenth-Century Mormonism as a Partial Asiatic Social Formation" In Perspectives in U. S. Marxist Anthropology. D. Hakken & H. Lessinger eds. Pp 102-122, Boulder: Westview.

Baer, Klaus
1960 Rank and Title in the Old Kingdom: The Structure of the Egyptian Administration in the 5th and 6th Dynasties. Chicago: University of Chicago Press.

Bagnall, Roger S.
1985 Currency and Inflation in Fourth Century Egypt. New York: Scholar Press.

Ball, John
1927 "Problems of the Libyan Desert" Geographical Teacher 70(1):21-38.

1930 "The Fayum Depression" Antiquity 4:467-471.

1939 Contributions to the Geography of Egypt. Cairo (Bulaq): Government Press, Survey and Mines Dept.

1942 Egypt and the Classical Geographers. Cairo (Bulaq): Government Press.

Ballman, Peter
1975 "Report on the Avain Remains from Sites in Egyptian Nubia, Upper Egypt and the Fayum" In Problems in Prehistory: North Africa and the Levant. Fred Wendorf and A. E. Marks, eds., Pp. 307-310. Dallas: Southern Methodist University Press.

Barois, Julien
1887 Les irrigations en Egypte. Paris: Librairie Polytechnique, Translated in 1889 by A.M. Miller as Irrigation in Egypt. Washington, D. C.: U. S. Government Printing Office.

Bates, Oric
1970 The Eastern Libyans: An Essay. London: Frank Cass.

Bates, Oric and John E. Wolf
1915 "A Nephrite Celt from the Fayum" Man 15:132-134.

al-Baz, Farouk
1984 The Geology of Egypt: An Annotated Bibliography. Leiden: E. J. Brill.

Beadnell, H.J.L.
1903 "Neolithic Flint Implements from the Northern Desert of the Fayum" Egypt Geological Magazine 10(1):53-59.

1905 "The Topography and Geology of the Fayoum Province in Egypt" Papers of the Geological Survey of Egypt Cairo: Government Printing Office.

Beard, Mary & John North
1990 Pagan Priests: Religion and Power in the Ancient World. Cornell, New York: Cornell University Press.

Bell, Harold I.
1953 Cults and Creeds in Greco-Roman Egypt. Chicago: Ares.

Belzoni, Geovani
1822 Narrative of Operations and Recent Discoveries in Egypt and Nubia. Third Edition, London: J. Murray.

Berger, Morroe
1970 Islam in Egypt Today: Social and Political Aspects of Popular Religion. London: Cambridge University Press.

Bernal, Martin
1987 Black Athena. New Brunswick: Rutgers University Press.

Bernard, Etienne
1981 Recueil des Inscriptons Greeques du Fayoum. Cairo: Institut Francais d'Archeologie Orientale, Bibliotheque d'etude (IFAO) Tomb 79-80.

Bernard, H. R.
1988 Research Methods in Cultural Anthropology. Newbury Park: Sage.

Bevan, Edwyn
1902 The House of Seleucus: A History of the Hellenistic Near East Under the Seleucid Dynasty. Chicago: Ares.

1906 The House of Ptolemy: A History of Hellenistic Near East Under The Ptolemaic Dynasty. Chicago: Ares.

Bianchi, Robert
1989 Unruly Corporatism: Associational Life in Twentieth-Century Egypt. New York: Oxford University Press.

Bigland, E.
1948 Journey to Egypt. London: Jarrolds.

Bishai, Helmy M. & Samir Y. Kirollus
1980 "The Water Budget of Lake Qarun and its Physio-chemical Characteristics" Water Supply and Management 4:93-97.

Biswas, Asit K.
1970 History of Hydrology. Amsterdam: North-Holland Publishing Company.

Bixler, Ray H.
1981 "Incest Avoidance as a Function of Environment and Hereditary" Current Anthropology 22(6):639-654.

1982 "On the Nonuniversality of Incest Avoidance" Current Anthropology 23(5):581-582.

Blackman, Winifred Susan
1922 "Some Occurrences of the Corn 'arusheh in Ancient Egyptian Tomb Paintings" Journal of Egyptian Archaeology 8:233-240.

1925a "Sacred Trees in Modern Egypt" Journal of Egyptian Archaeology 11:56-57.

1925b "An Ancient Egyptian Custom Illustrated by Modern Survival" Man 25:38:65-67

1926a "Some Social & Religious Customs in Modern Egypt With Special Reference to Survivals from Ancient Times" Bulletin de la Societe de Geographie d'Egypte 14:46-61.

1926b "The Karin and Kariheh" Journal of the Royal Anthropological Institute 56:163-169.

1927 _The Fellahin of Upper Egypt: Their Religious Social and Industrial Life Today with Special Reference to Survival From Ancient Times_. London: George G. Harrap.

1933 "Some Further Notes on a Harvesting Scene" _Journal of Egyptian Archaeology_ 19:31-32.

Blaut, J. M.
1989 "Colonialism and the Rise of Capitalism" _Science and Society_ 53(3):260-296.

Blunt, Wilfred S.
1967 _Secret History of the English Occupation of Egypt, Being a Personal Narrative of Events_. [orignally 1865] New York: H. Fertig.

Boak, Arthur E. R.
1913 _Karanis_. University of Michigan Studies, Humanistic Series, Vol. 30, Ann Arbor: University of Michigan Press.

1926 "Irrigation and Population in the Faiyum, The Garden of Egypt" _The Geographical Review_ 16(3):353-364.

1935 _Soknopaiou Nesos: The University of Michigan Excavations at Dime in 1931-1932_. Ann Arbor: University of Michigan Humanistic Series.

Boinet, A.,
1892 _Geographic economique et administration de l'Egypte_. Cairo: Imprimerie Nationale.

Bolin, I.
1990 "Upsetting the Power Balance: Cooperation, Competition and Conflict Along the Andean Irrigation System" _Human Organization_ 49:140-148.

Bonneau, Danielle
1979 "La terre 'Arrosee par le nil' Neilobrochos" _Bulletin of the American Society of Papyrologists_ 16:13-24.

1982 "Le drymos (drumov), marais du Fayoum, d'apres la documentation papyrologique" In _L'Egyptologie en 1979: Axes prioritaire de recherches_. Jean Leclant, ed. Pp. 181-190. Paris: CNRS.

van der Boorn, G. P. F.
1988 _Duties of the Vizier: Civil Administration in the Early New Kingdom_. London: Kegan Paul International.

Boraey, Fawzy A.
1980 "Studies on the Changes of Some Ecological factors Affecting Fish in Lake Qarun, Faiym, Egypt" Water Supply and Management 4:99-102.

Bornkamm, Reinhard & Harold Kehl
1989 "Landscape Ecology of the Western Desert of Egypt" Journal of Arid Environments 17(2):271-277.

Borrer, Dawson
1845 A Journey from Naples to Jerusalem, by way of Athens, Egypt, and the Peninsula of Sinai, including a trip to the Valley of Fayoum. London: J. Madden and Co.

Bos, M. G., J. A. Replogle & A. J. Clemmens
1984 Flow Measuring Flumes For Open Channel Systems. New York: John Wiley & Sons.

Boserup, Ester
1965 The Condition of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure. Chicago: Aldine.

1981 Population and Technological Change: A Study of Long-Term Trends. Chicago: University of Chicago Press.

Botman, Selma
1987 "The Egyptian Communist Movement in Historical Perspective" Journal of South Asian and Middle Eastern Studies 10(3):78-94.

Boulos, Loutfy & M. Nabil el-Hadidi
1984 The Weed Flora of Egypt. Cairo: American University in Cairo Press.

Bowman, Alan
1986 Egypt After the Pharaohs. Berkeley: University of California Press.

Bown, Thomas & Mary J. Kraus
1988 Geology and Paleoenvironment of the Oligocene Jebel Qatani Formation and Adjacent Rocks, Fayoum Depression, Egypt. Washington, D. C.: U.S. Government Printing Office.

Bown, T.M., M.J. Kranse, J.T. Fleagle, B. Tiffany & E.L. Simons
1982 "The Fayum Primate Forest Revisited" Journal of Human Evolution 11:603-632.

Brewer, Douglas J.
1985 "The Fayoum Zooarchaeological Survey: A Preliminary Report" Newsletter of the American Research Center in Egypt 128:5-14.

1989 Fishermen, Hunters, and Herders: Zooarchaeology in the Fayum, Egypt (ca. 8200-5000 bp). London: British Archaeological Reports Report.

1991 "Temperatures in Predynastic Egypt Inferred from the Remains of the Nile Perch" World Archaeology 22(3):288-303.

Brewer, Douglas & Renee F. Friedman
1989 Fish and Fishing in Ancient Egypt. Warminster, UK: Aris & Phillips.

Bromley, Daniel W., Donald C. Taylor & Donald E. Parker
1980 "Water Reform and Economic Development: Institutional Aspects of Water Management in Developing Countries" Economic Development and Cultural Change 28:365-387.

Brookes, Ian A.
1989 "Above the Salt: Sediment Accretion and Irrigation Agriculture in an Egyptian Oasis" Journal of Arid Environments 17(3):335-348.

Brown, Nathan J.
1990a Peasant Politics in Modern Egypt. New Haven: Yale University Press.

1990b "Brigands and State Building: The Invention of Banditry in Modern Egypt" Comparative Studies in Society and History 32(2):258-281.

Brown, Robert Hanbury
1892 The Fayum and Lake Moeris. London: Edward Standford.

1905 "Irrigation Under British Engineers in Indian and Egypt" American Society of Civil Engineers, Transactions 54(8):3-32.

1907 Irrigation: Its Principles and Practices as a Branch of Engineering. London: Archibald Constable & Co.

1908 "Irrigation in Egypt Under British Direction" Royal Society of Arts Journal 56(8):415-428.

Browne, G.
1967 "Two land Leases From First Century Tebtunis" Bulletin of the American Society of Papyrologists 4:5-12.

Bruneau, Michael
1982 "Mode of Production and Spatial Organization in Thailand: Process and Trends" Antipode 14(1):1-10.

Brunton, G.
1920 Lahun 1: The Treasure. London: Brill.

Butler, Alfred J.
1884 The Ancient Coptic Churches of Egypt. 2 volumes. Oxford: Clarendon Press.

Butzer, Karl
1960 "Remarks on the Geography of Settlement in the Nile Valley During Hellenistic Times" BSGE 33:5-36.

1971 Environment and Archeology: An Ecological Approach to Prehistory. Chicago: Aldine Publishing Company.

1975a"Birket Qarun" in Wolfgang Welck & Eberhard Otto eds, Lexikon der Agyptologie 1, Pp. 822-824. Wiesbaden: JDC.

1975b "Bahr Jussuf" in Lexikon der Agyptologie 1. eds, Wolfgang Welck & Eberhard Otto. Wiesbaden: JDC.

1975c "Patterns of Environmental Change in the Near East During Late Pleistocene and Early Holocene Times" In Problems in Prehistory: North Africa and the Levant. Wendorf and Marks, eds. Pp. 389-410. Dallas: Southern Methodist University Press.

1976 Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology. Chicago: University of Chicago Press.

1978a "Perspectives on Irrigation in Pharonic Egypt" In Immortal Egypt: Invited Lectures on the Middle East at the University of Texas at Austin. Denise Schmandt-Besserat, ed. Pp. 13-18. Malibu, California: Undena Publications.

1978b "Review of Mark Cohen's Food Crisis in Prehistory." Annals of the Association of American Geographers 68(1):125-127.

1980a "Civilizations: Organisms or Systems?" American Scientist 68:517-523.

1980b "Pleistocene History of the Nile Valley in Egypt and Lower Nubia" In The Sahara and the Nile. M. Williams & H. Faure, eds. Pp. 253-280. Rotterdam.

1984 "Long-Term Nile Flood Variation and Political Discontinuities in Pharaonic Egypt" In From Hunters to Farmers: The Causes and Consequences of Food Production in Africa. J. D. Clark & S. A. Brandt, eds. Pp. 102-112. Berkeley: University of California Press.

Butzer, Karl & Carl Hansen
1968 Desert River in Nubia: Geomorphology and Prehistoric Environment at the Aswan Reservoir. Madison: University of Wisconsin Press.

Cahen, Claude
1948 "Quelques aspects de l'administration egyptienne medievale vus par un de ses fonctionnairres" Bulletin de la Faculte des Lettres de Strasbourg 26 annee Pp. 97-118.

1956 "Le regime des impots dans le Fayyum Ayyubide" Arabica 3(1):8-30.

Caponera, D. A.
1973 Water Laws in Muslim Countries. Rome: FAO Irrigation and Drainage Paper, No. 20.

Carnerro, Robert
1962 "Scale Analysis as an Instrument for the Study of Cultural Evolution" Southwestern Journal of Anthropology 18:149-169.

1968 "Ascertaining, Testing and Interpreting Sequences of Cultural Development" Southwestern Journal of Anthropology 24:354-374

1970 "A Theory of the Origin of the State" Science 169:733-738.

1978 "Political Expansion as an Expression of the Principle of Competitive Exclusion." In Origins of the State, Ron Cohen and Elman Service, eds. Pp. 205-223. Philadelphia: ISHI.

1988 "The Circumscription Theory: Challenge and Response" American Behavior Scientist 31(4):497-511.

Casey, Hugh
1972 Salinity Problems in Arid Lands Irrigation: A Literature Review and Selected Bibliography. Tucson: Arid Lands Resource Information Paper, No. 1.

Castillos, Juan Jose
1970 "Further Remarks on the Fayum A and B Settlements" Journal of the Society for the Study of Egyptian Antiquities 5(2):3-4.

1973 "Fayum A and B Settlements" Journal of Egyptian Archaeology 59:218.

Caton-Thompson, G.
1925 "Preliminary Report on Neolithic Pottery and Bone Implements from the Northern Fayum Desert, Egypt" Man 25(1):153-156.

1926 "The Neolithic Industry of the Northern Fayum Desert" Journal of the Royal Anthropological Institute of Great Britain and Ireland 56(2):309-323.

1927 "Explorations in the Northern Fayum" Antiquity 1:326-340.

1928a "Recent Excavations in the Fayoum" Man 28(80):109-213.

1928b "Neolithic Fayum Pottery" Ancient Egypt September (part 3) Pp. 70-89.

Caton-Thompson, G. & E. W. Gardner
1926a "Research in the Fayum" Ancient Egypt pt. 1. Pp. 1-4.

1926b "The Recent Geology and Neolithic Industry of the Northern Fayum Desert" Journal of the Royal Anthropological Institute of Great Britain and Ireland 61:301-323.

1929 "Recent Work on the Problem of Lake Moeris" The Geographical Journal 73(1):20-60.

1934 The Desert Fayum. London: Royal Anthropological Institute.

Caton-Thompson, G., E. W. Gardner & S. A. Huzayyin
1937 "Lake Moeris: Reinvestigations & Some Comments" Bulletin de l'Institut d'Egypte tome 19:243-290.

Central Agency for Public Mobilisation [sic] and Statistics
1989 Statistical Year Book: Arab Republic of Egypt. Cairo: Governmental Printing Office.

Cerny, J.
1975 "Egypt: From the Death of Ramses III to the End of the Twenty First Dynasty" The Cambridge Ancient History 3rd edition, Volume II, Part 2, edited by I.E.S. Edwards, Pp. 606-657. Cambridge: Cambridge University Press.

Chaichian, M.
1988 "The Effects of World Capitalist Economy on Urbanization in Egypt 1800-1970" International Journal of Middle East Studies 20(1):23-43.

Churchill, Randolph Spencer
1966 Winston S. Churchill. Volume 7. Boston: Houghton Mifflin.

Close, Angela E.
1984 "Current Research and Recent Radio Carbon Dates From Northern Africa Part 11" Journal of African History 25:1-24.

Close, Angela E., (ed.)
1987 Prehistory of Arid North Africa: Essays in Honor of Fred Wendorf. Dallas: Southwestern Methodist University Press.

Cohen, Gerald A.
1978 Karl Marx's Theory of History: A Defence. Princeton: Princeton University Press.

Cohen, Mark
1977 The Food Crisis in Prehistory. New Haven: Yale University Press.

Cohen, Ronald
1977 "State Foundations: A Controlled Comparison" In Origins of the State. R. Cohen and E. Service, eds. Pp. 141-160. Philadelphia: Institute for the Study of Human Issues.

Cohen, Ronald and Elman Service (eds.)
1977 Origins of the State: The Anthropology of Political Evolution. Philadelphia: Institute for the study of Human Issues.

Conklin, Harold
1980 Ethnographic Atlas of Ifugao: A Study of Environment, Culture, and Society in Northern Luzon. New Haven: Yale University Press.

Connor, Douglas R. & Anthony E. Marks
1986 "The Terminal Pleistocene of the Nile: The Final Nilotic Adjustment" In The End of the Paleolithic in the Old World. British Archaeological Reports 284 Lawrence Strauss, ed. Pp. 171-199. London: British Archaeological Reports.

Conroy, Glenn C.
1974 "Primate Postcranial Remains from the Fayoum Province, Egypt, U.A.R." Ph. D. dissertation, Yale University.

Coward, E. W.
1990 "Property Rights and Network Order: The Case of Irrigation Works in the Western Himmalayas" Human Organization 49:78-88 (spring).

Crawford, Dorthy J.
1971 Kerkeosiris: An Egyptian Village in the Ptolemaic Period. Cambridge: Cambridge University Press.

de ste. Croix, G. E. M.
1981 The Class Struggle in the Ancient Greek World. Cornell: Cornell University Press.

Cunningham, Andrew
1990 "Leaving Debtors out in the Cold" Middle East Economic Digest Jan. 12:4-5.

Cuno, Kenneth M.
1984 "Egypt's Wealthy Peasantry, 1740-1820: A Study of the Region of al-Mansura" In Land Tenure and Social Transformation in the Middle East. T. Khalidi, ed. Pp. 303-332. Beirut: American University Beirut Press.

1985 "Landholding Society and Economy in Rural Egypt, 1740-1850: A Case Study in al-Daqahliyya Province" Ph. D. dissertation, University of California Los Angeles.

Currie, Kate
1984 "The Asiatic Mode of Production: Problems of Conceptualizing State and Economy" Dialectical Anthropology 8:251-268.

David, A. Rosalie
1982 The Ancient Egyptians: Religious Beliefs and Practices. London: Routledge and Kegan Paul.

1986 The Pyramid Builders of Ancient Egypt: A Modern Investigation of Pharaoh's Workforce. London: Routledge & Kegan Paul.

Davis, Eric
1983 Challenging Colonialism: Bank Misr and Egyptian Industrialization 1920-1941. Princeton: Princeton University Press.

Davis, Norman & Colin M. Kray
1973 The Hellenistic Kingdoms. London: Thames and Hudson.

al Deeb, Bothayna
1988 The State of Egyptian Children. Cairo: Arab World Publishing House.

Deeb, Marius
1984 "Large Landowners and Social Transformation in Egypt 1940-1952" In Land Tenure and Social Transformation in the Middle East. T. Khalidi, ed. Pp. 425-436. Beirut: American University Beirut Press.

al-Dessouki, Assem
1984 "Land Tenure Policy in Egypt, 1952-1969, and its Effects on the Reformation of the Peasantry" In Land Tenure and Social Transformation in The Middle East T. Khalidi, ed. Pp. 437-448. Beirut: American University Beirut Press.

Development & Technological Planning Research Centre
1980 "Fayoum Development and Plannification Project: Present Conditions and Filed Studies" Cairo: Development and Technological Planning Research Centre.

Dickson, D. Bruce
1987 "Circumscription by Anthropogenic Environmental Destruction: An Expansion of Carneiro's (1970) Theory of the Origin of the State" American Antiquity 52(4):706-716.

Diodorus, Siculus
1985 Diodorrus on Egypt: Book I of Diodorus Siculus' Historical Library. Translated by Edwin Murphy. Jefferson, North Carolina: McFarland.

al-Disuqi, Asim
1976 Kibar al-mullak al-ardi al-ziraiya wa duruhum fi-l-mujtima al-misri, 1914-1952. Cairo: Dar al-Thaqafa al-Jadida Press.

Doolittle, William E.
1990 Canal Irrigation in Prehistoric Mexico: The Sequence of Technological Change. Austin: University of Texas Press.

Douglas, J. Leigh
1987 The Free Yemeni Movement 1935-1962. Beirut: American University Press.

Drachmann, Aage Ger
1963 Mechanical Technology of Greek and Roman Antiquity. Madison: University of Wisconsin Press.

Draper, Hal
1977 Karl Marx's Theory of Revolution, Vol. 1, State and Bureaucracy. New York: Monthly Review Press.

1978 Karl Marx's Theory of Revolution, Vol. 2 The Politics of Social Classes. New York: Monthly Review Press.

Driesch, Angela von den
1987 "Tierknochenfunde aus Qasr el-Sagha/Fayum (Neolithikum und Mitttleres Reich)" Mitteilungen des Deutschyen Archaological Instituts Abtteilung Kairo 42:1-8.

Drower, M. S.
1954 "Water-Supply, Irrigation, and Agriculture" In A History of Technology. Charles Singer, E. J. Holmyard & A.R. Hall, eds. Pp. 520-557. Oxford: Clarendon Press.

Dumont, Rene
1973 "The Effects of the Rising Tide of Population on the Modest Progress of Bureaucratic-Military Socialism in Egypt" In Socialism and Development (Translated by Rupert Cunningham) R. Dumont, ed. Pp. 1185-1207. New York: Praeger.

Duncan-Jones, Richard
1990 Structure and Scale in the Roman Economy. Cambridge: Cambridge University Press.

Dunn, Stephen P.
1982 The Fall and Rise of the Asiatic Mode of Production. London: Routledge and Kegan Paul.

Dyson-Hudson, Neville (ed.)
1972 Perspectives on Nomadism. Leiden: E. J. Brill.

Earle, Timothy
1987 "Chiefdoms in Archaeological and Ethnohistorical Perspective" Annual Review of Anthropology 16:279-308.

Early, Evelyn Aleene
1981 "Bahithat al-Badiya: Cairo Viewed From the Fayyum Oasis" Journal of Near Eastern Studies 40:339-341.

Ebers, Georg Moritz
1893 The Hellenic Portraits from the Fayum at Present in the Collection of Herr Graf.

Egyptian Ministry of Population
1986 Population and Housing Census: Fayoum. Cairo: Government Press.

Ekram, Abdel Salam
1986 "Discrepancies in Outcome of a Control Program for Schistosomiasis Haematobia in Fayoum Governorate, Egypt" American Journal of Tropical Medicine and Hygiene 35(4):786-790.

Elassiouti, Ibrahim M.
1990 "Environmental Aspects of Water Resources Development" In Hydraulics/Hydrology of Arid Lands. Richard H. French, ed. Pp. 1-6. New York: American Society of Civil Engineers.

Elster, Jon
1985 Making Sense of Marx. Cambridge: Cambridge University Press.

Enge, Kjell I. & Scott Whiteford
1989 The Keepers of the Water and Earth: Mexican Rural Social Organization and Irrigation. Austin: University of Texas Press.

Engels, Frederick
1853 "Engels to Marx, June 6, 1853" In Marx, Engels Works. Pp. 258-261.

1884 [1974] The Origin of the Family, Private Property and the State. New York: International Publishers.

1894 [1954] Anti-Duhring: Herr Eugen Duhring Revolution in Science. Moscow: Foreign Languages Publishing House. Translation of 3rd edition.

Evans-Pritchard, E.E.
1940 The Nuer: A Description of Modes of Livelihood and Political Institutions of a Nilotic People. Oxford: Clarendon Press.

Eyre, John D.
1955 "Water Control in Japanese Irrigation System" Geographical Review 45:97-116.

F.A.D.P.
1982 Fayoum Agricultural Development Project: Feasibility Study. Sabbour Associates--Cairo: Agrar-Und Hydrotechnik GMBK.

Fagan, Brian M.
1975 The Rape of the Nile: Tomb Robbers, Tourists, and Archaeologists in Egypt. New York: Charles Scribner's Sons.

Field, Henry
1952 Contributions to the Anthropology of The Faiyum, Sinai, Sudan, Kenya. Berkeley: University of California Press.

1953 The Track of Ancient Man. Garden City, New York: Doubleday.

Fleagle, J.G., T.M. Bown & J.D. Obrabovich & E.L. Simons
1986 "How Old are the Fayum Primates?" In Primate Evolution. J.G. Else and P.C. Lee, eds. Cambridge: Cambridge University Press.

Fleagle, J. G. & R. F. Kay
1983 " New Interpretations of Phyletic Position of Oligocene Hominids" In New Interpretations of Ape and Human Ancestry. R. Ciochon & R. Corruccini, eds. Pp. 180-210. New York: Plenum Press.

Fleuret, Patrick
1985 "The Social Organization of Water Control in the Taita Hills, Kenya" American Ethnologist 12(1):103-118.

Forbes, R. J.
1956 Studies in Ancient Technology. Vols 1-6. Leiden: David 1986.

Forde-Johnston, J. L.
1959 Neolithic Cultures of North Africa: Aspects of one Phase in the Development of the African Stone Age Cultures. London: Liverpool University Press.

France, Peter
1991 The Rape of Egypt. London: Barrie & Jenkins.

Frantz-Murphy, Gladys
1984 "Land Tenure and Transformation in Early Islamic Egypt" In Land Tenure and Social Transformation in The Middle East. T. Khalidi, ed. Pp. 131-139. Beirut: American University Beirut Press.

1986 The Agrarian Administration of Egypt From the Arabs to the Ottomans. Le Caire: Supplement aux annales islamologiques Cahier No. 9.

Fraser, P. M.
1972 Ptolemaic Alexandria. London: Oxford University Press.

Freeman, David M., Husein Azadi & Max K. Lowdermilk
1982 "Power Distribution and Adoption of Agricultural Innovations: A Structural Analysis of Villages in Pakistan" Rural Sociology 47:68-80.

Fried, Morton H.
1967 The Evolution of Political Society: An Essay In Political Anthropology. New York: Random House.

1978 "Reconsiderations: Oriental Despotism" Human Nature 1(12):90-93.

Gadalla, Saad M.
1962 Land Reform in Relation to Social Development, Egypt. Columbia: University of Missouri Press.

Garbrecht, Gunther
1987 "Hydrologic and Hydraulic Concepts in Antiquity" In Hydraulics and Hydraulic Research: A Historical Review. G. Garbrecht, ed. Pp. 1-22. Boston: A. A. Bulkema.

Gardiner, A.H.
1943 "The Name of Lake Moeris" Journal of Egyptian Archaeology 29:37-46.

Gardner, E. W.
1926 "The Recent Geology of the Northern Fayum Desert" Journal of the Royal Anthropological Institute of Great Britain and Ireland 61(2):301-308.

1927a "The Recent Geology of the Northern Fayum Desert" The Geological Magazine 74(759):386-410.

1927b "The Origin of the Faiyum Depression" The Geological Journal 74(4):37-383.

Gardner, John
1983 The Art of Fiction. New York: Alfred A. Knopf.

Gazda, E.K. (ed.)
1978 Guardians of the Nile: Sculpture from Karanis in the Fayoum (c. 250 B.C.- A.D. 450). Ann Arbor: University of Michigan Press.

Geertz, Cliford
1963 Agricultural Involution: The Process of Ecological Change in Indonesia. Berkeley: University of California Press.

1973 The Interpretation of Cultures. New York: Basic Books.

Giddy, Lisa L.
1987 Egyptian Oases: Baharriya, Dakhla, Farafra and Kharga During Pharaonic Times. London: Aris & Phillips Ltd.

Ginter, B., W. Heflik, J.K. Kozlowski and J. Sliwa
1980 Excavations in the Region of Qasr el Sagha 1979: Contributions to the Holocene Geology' the Predynastic Settlements in the Northern Fayum Desert. Mitteilungen des Deutschen Archaologischen Instituts Abteilung Kairo Vol. 36:105-169.

Ginter, B. & J. K. Kozlowski
1983 "Investigations on Neolithic Settlement" In Qasr el-sagha 1980. Kozlowski, ed. Pp. 37-67. Warsaw: Panstwowe Wydawnictwo Naukow.

1987 "Kulturelle und palaoklimatische Sequenz in der Fayum Depression--eine zusammenfassende Darstellung der Forschungsarbeiten in den Jahren 1979-1981" Mitteilungen des Deutschen Archaologischen Instituts Abteilung Kairo 42:9-24.

Glenn, Sigrid S.
1991 "Contingencies and Metacontingencies: Relations Among Behavioral, Cultural, and Biological Evolution" In Press. Pp. 39-73.

n.d. "Behavioral Selection and Cultural Contingencies" Paper Delivered at Southeastern Association for Behavior Analysis, Charleston, S.C., October 1985.

Glick, Thomas
1970 Irrigation and Society in Medieval Valencia. Cambridge: Cambridge University Press.

Godelier, Maurice
1978 "The Concept of the 'Asiatic Mode of Production' and Marxist Models of Social Evolution" In Relations of Production: Marxist Approaches to Economic Anthropology. David Seddon, ed. Pp. 209-257. London: Frank Cass.

Goodman, Steven M., Patrick F. Houlihan & Ibrahim Helmy
1984 "Recent Records of the Ostrich Struthio camelus in Egypt" Bulletin of the British Ornithological Club 104(2):39-44.

Goody, Jack
1973 Bridewealth & Dowry. Cambridge Papers in Social Anthropology No. 7 Cambridge: Cambridge University Press.

1990 The Oriental, the Ancient and the Primitive: Systems of Marriage and the Family in the Pre-industrial Societies of Eurasia. Cambridge: Cambridge University Press.

Goudriaan, Koen
1988 Ethnicity in Ptolemaic Egypt. Amsterdam: J. C. Gieben.

Goyon, Georges
1971 "Les ports des pyramides et le grand canal de memphis" Rev. Egyptol. 23:137-153.

Graber, Robert B & Paul B. Roscoe
1988 "Circumscription and the Evolution of Society" American Behavioral Scientist 31(4):405-415.

Graham, A. J.
1964 Colony and Mother City in Ancient Greece. Chicago: Ares.

Greene, Kevin
1986 The Archaeology of the Roman Economy. Berkeley: University of California Press.

Grenfell, Hunt & Hogarth
1900 "Some Fayoum Towns and their Papyri" London: Egypt Exploration Fund Archaeology Report.

Griffith, F. L.
1897a Hieratic Papyris from Kahun and Gurub. Vol. I: Literary, Medical and Mathematical Papyri From Kahun. London.

1897b Hieratic Papyris from Kahun and Gurub. Vol. III: Additional Notes, Corrrections, Indicies. London.

1898 Hieratic Papyri from Kahun and Gurob Vol. II: Legal Documents, Account Papyri etc. and Letters from Kahun, Gurrob Papyri. London.

Griffith, G. T.
1935 The Mercenaries of the Hellenistic World. Cambridge: Cambridge University Press.

Guillet, David
1987 "Terracing and Irrigation in the Peruvian Highlands" Current Anthropology 28(4):409-430.

Gunn, B.
1945 The Name of the Pyramid-Town of Sesostris II Journal of Egyptian Archaeology 31:106-107.

Haarmann, Ulrich
1984 "The Sons of Mamluks as Fief-Holders in Late Medieval Egypt" In Land Tenure and Social Transformation in the Middle East. T. Khalidi, ed. Pp. 141-168. Beirut: American University Beirut Press.

Haddad, Yvonne Y.
1987 "Islamic 'Awakening' in Egypt" Arab Studies Quarterly 9(3):234-259.

Hafez, M., H. el-Tahan, M. Awadalla, H. el-Khayat
1983 "Consanguineous Matings in the Egyptian Population" Journal of Medical Genetics 20(1):58-60.

Hall, H.R.
1921 "Egypt and the External World in the Time of Akhenaten" Journal of Egyptian Archaeology 7:39-53.

Halm, Heinz
1979 Agypten nach den mamlukischen Lehensregistern 1. Oberagypten und das Fayyum. Wiesbaden: Kommission bei Dr. Ludwig Reichert.

1982 "Agypten nach den mamlukischen Lehensregistern. vol II: Das Delta" TAVO Nr 38/2.

Hamid, Ru'uf 'Abbis
1973 al-nizam al itjtima'i fi misr fi zill al-milkiyat al-zira'iya al-kabira, 1837-1914. Cairo: Dar al-Fikr al-Hadith.

Hancock, Graham
1989 Lords of Poverty: The Power, Prestige and Corruption of the International AId Business. New York: Atlantic Monthly Press.

Hansen, B.
1984 "An Economic Model for Ottoman Egypt: The Economics of Collective Tax Responsibility" In The Islamic Middle East, 700-1900: Studies in Economic and Social History. Udovitch, ed. Pp. 473-519. Princeton: Princeton University Press.

Hardy, Edward R.
1931 The Large Estates of Byzantine Egypt. New York: Columbia University Press.

1952 Christian Egypt. Oxford: Oxford University Press.

Harner, Michael
1970 "Population Pressure and the Social Evolution of Agriculturalists" Southwestern Journal of Anthropology 26:67-86.

Harris, Marvin
1968 The Rise of Anthropological Theory. New York: T. Crowell.

1977 Cannibals and Kings: The Origins of Cultures. New York: Random House.

1979 Cultural Materialism: The Struggle For a Science of Culture. New York: Random House.

1988 Culture, People, Nature. Fifth Edition. New York: Harper & Row.

1989 Our Kind. New York: Simon and Schuster.

Harris, Marvin & Eric Ross
1987 Death Sex and Fertility. New York: Columbia Univeristy Press.

al-Hassan, Ahmad Y. & Donald R. Hill
1986 Islamic Technology: An Illustrated History. UNESCO and Cambridge University Press.

Hassan, Fekri
1973 "On Mechanisms of Population Growth During the Neolithic" Current Anthropology 14(5):535-540.

1980a "Radio Chronology of Archaic Egypt" Journal of Near Eastern Studies 39(3):203-207.

1980b "Prehistoric Settlements Along the Main Nile" In The Sahara and the Nile. M. Williams & H. Fuare, eds. Pp. 421-451. Rotterdam: A. A. Balkema.

1983 "The Origins of the Egyptian Civilization: A Working Model" Annales du Service des Antiquites de l'Egypte 65:135-148.

1984a "Environment and Subsistence in Predynastic Egypt" In From Hunters to Farmers: The Causes and Consequences of Food Production in Africa. J. D. Clark & S. A. Brandt, eds. Berkeley: University of California Press.

1984b "Toward a Model of Agricultural Development in Predynastic Egypt" In Origin and Early Development of Food-Producing Culture. L. Krzyzaniak and Kobusiewicz, eds. Pp. 221-224. Poznan: Poznan Archaeology Museum.

1986a "Desert Environment and Origins of Agriculture in Egypt" Norwegian Archaeology Review 19:63-76.

1986b "Holocene Lakes and Prehistoric Settlements of the Western Faiyum, Egypt" Journal of Archaeological Science 13:483-501.

Hays, T. R.

1975 "Neolithic Settlement of the Sahara as it relates to the Nile Valley" In Problems in Prehistory. Fred Wendorf and A. E. Marks, eds. Pp. 193-201. Dallas: Southern Methodist University Press.

1984 "A Reappraisal of the Egyptian Predynastic" In From Hunters to Farmers: The Causes and Consequences of Food Production in Africa. In J. D. Clark & S. A. Brandt, eds. Pp. 65-73. Berkeley: University Of California Press.

Hays, William C.

1964 "Most Ancient Egypt" Journal of Near Eastern Studies 23(3):145-274;, 23(4):217-266.

1971 "The Middle Kingdom in Egypt: Internal History from the Rise of the Heracleopolitans to the Death of Ammenemes III", In Cambridge Ancient History, Vol. 1, Pt. 2. I.E.S. Edwards, ed. Pp. 464-331. Cambridge: Cambridge University Press.

Headland, Thomas N., Kenneth L. Pike & Marvin Harris, eds.

1990 Emics and Etics: The Insider / Outsider Debate. Newbury Park, California: Sage.

Heath, D. D.

1886 "Herodotus in Egypt" Journal of Philogy 15:215-240.

Hedges, Chris
1992 "Egypt Tightens the Net Around Its Militant Opposition" New York Times 10 December, Pp. A3.

Heikal, Mohamed
1983 Autumn of Fury: The Assassination of Sadat. New York: Random House.

Herodotus
1910 The Histories. C.W. Elliot, ed. New York: Collier.

Hester, James J. & Philip M. Hoebler
1969 Prehistoric Settlement Patterns in the Libyan Desert. Salt Lake City: University of Utah Papers in Anthropology No. 92 (Nubian Series, 4).

Hewison, Neil
1986 The Fayoum: A Practical Guide. Second Edition. Cairo: American University Press.

Higgs, E.S.
1967 "Early Domesticated Animals in Libya" In Background to Evolution in Africa. Bishop and D. Clark, eds. Pp. 165-173. Chicago: University of Chicago Press.

Hill, Donald R.
1984 A History of Engineering in Classical and Medieval Times. London: Croom Helm.

1991 "Mechanical Engineering in the Medieval Near East" Scientific American May, 1991. Pp. 100-105.

Hill, Enid
1979 Mahkama!: Studies in the Egyptian Legal System. London: Ithaca Press.

Hinnebusch, Raymond A.
1983 "From Nasser to Sadat: Elite Transformation in Egypt" Journal of South Asian and Middle Eastern Studies 7(1):24-49.

Hobson, Deborah
1984 "Agricultural Land and Economic Life in Soknopaiou Nesos" Bulletin of the American Society of Papyrologists 21:89-109.

1985 "The Village of Heraklia in the Arsinoite Nome" Bulletin of the American Society of Papyrologists 22:101-115.

Hogarth, D.G. & B.P. Grenfell
1897 "Cities of the Faiyum" Egypt Exploration Fund Archaeological Report Pp. 14-19.

Holt, P.M.
1953 "al-Fayyum" Encyclopedia of Islam. Pp. 247. Ithaca: Cornell University Press.

1970 "The Later Ottoman Empire in Egypt and the Fertile Crescent" In The Cambridge History of Islam. P.M. Holt, A.K.S. Lambron and B. Lewis, eds. Pp. 374-393. Cambridge: Cambridge University Press.

Hopkins, Keith
1980 "Brother-Sister Marriage in Roman Egypt" Comparative Studies of Society and History 22(3):303-354.

Hopkins, Nicholas
1987 Agrarian Transformation in Egypt. Boulder: Westview.

Hornel, James
1947 "Egyptian and Medieval Pigeon-Houses" Antiquity 21:84:182-185.

Hudson, Michael C.
1991 "After the War: Prospects for Democracy in the Arab World" Middle East Journal 45(3):407-426.

Hug, G.
1926 "Un Plan en Relief du Fayoum" Bulletin de la Societe Royale de Geographie d'Egypte 14:169-172.

1927"Le Moeris: Etude de Geographie Physique Historique" Bulletin de la Societe Royale de Geographie d'Egypte 15:1-50.

1929 "Apercu d'ensemble sur la Geographie Physique du Fayoum" Bulletin de la Societe Royale de Geographie d'Egypte 17:61-76.

Hume, W. J.
1912 "Explanatory Notes to Accompany the Geological Map of Egypt" Cairo: Survey Dept.

Hunt, A.S.
1898 "A Thucydides Papyrus from Oxyrhynchus" Egyptian Exploration Fund Archaeological Report 1893 Report Pages 13-20.

Hunt, Robert C.
1988 "Size and Structure of Authority in Canal Irrigation Systems" Journal of Anthropological Research 44(4):335-355.

1989 "Appropriate Social Organization? Water User Associations in Bureaucratic Canal Irrigation Systems" Human Organization 48(1):79-90.

Hunt, Robert C. & Evan Hunt
1974 "Irrigation, Conflict and Politics: A Mexican case. In Irrigation's Impact on Society. T. Downing & M. Gibson, eds. Pp. 127-158. Tucson: University of Arizona Press.

1976 "Canal Irrigation and Local Social Organization" Current Anthropology 17(3):389-411.

Hunter, F. Robert
1984 Egypt Under the Khedives, Eighteen Five to Eighteen Seventy Nine: From Household Government to Modern Bureaucracy.Pittsburgh: University of Pittsburgh Press.

Hussein, Mahmoud
1973 Class Conflict in Egypt: 1945-1970. New York: Monthly Review Press.

Husselman, Elinor M.
1971 Papyri from Karanis. Third Series (Michigan Papyri, Vol IX). Philological Monographs of the American Philological Association. Number 29.

Ibn Iyas
1945 Histore des Mamelouks Cirassiens. (Translated by G. Weit) Cairo: Publications de l'Institut Francais d'Archeologie Orientale: Textes et Traductions d'auteurs orienta,ux. t. 6.

Ibrahim, Youssef M.
1993 "Muslims' Fury Is Falling On Egypt's Christians" New York Times Monday, March 15, Page A1-A4.

Iisaa, Salaah 'abd al-Jaabir
1984 Tanmiit wa-takhtiit al-mustawtanaat al-Riifiyyah: Diraasah Jughraafiyyah Usuuliyyah wa tatbiiqiyyah.,Al Qaahirah: Maktabat al-Nahdah al-Misriyyah.

Irwin, Robert
1984 The Middle East in the Middle Ages: The Early Mamluk Sultanate 1250-1382. Carbondale: Southern Illinois University Press.

Issawi, Bahay
1976 "Geology of the Fayum Depression" In Prehistory of the Nile Valley. F. Wendorf & R. Schild, eds. Pp. 151-153. New York: Academic Press.

al-Jabarti, Abd al-Rahman
1975 Tarikh muddat al-faransis bimisr. Lidan: Brill.

Johnson, Alan Chester
1959 Roman Egypt: To The Reign of Diocletian. Volume II In An Economic Survey of Ancient Rome. H. Frank Series Editor. Paterson, New Jersey: Pageant Books.

Johnson, A.C. & L.C. West
1967 Byzantine Egypt: Economic Studies. New York: Coronet Books.

Johnson, Douglas L.
1973 "Jabl al-Akhdar Cyrenaica." Chicago: University of Chicago, Department of Geography Research Paper No.148.

Johnson, Janet H.
1986 "The Role of the Egyptian Priesthood in Ptolemaic Egypt" In Egyptological Studies in Honor of Richard A. Parker. Leonard H. Lesko, ed. Pp. 70-84. Hanover, MA: Brown University Press.

Jomard, E. F.
1819 Memoire sur le lac de Moeris Description de l'Egypte: Antiques, memoires. Tome 1, Paris.

1822 Memoires sur le Lac de Moeris compare a celui du Fayum in Descripton de l'Egypte, Paris 2 eme.

Jonas, Hans
1958 The Gnostic Religion: The Message of the Alien God and the Beginnings of Christianity. Boston: Beacon Press.

Jones, Eric Lionel
1987 The European Miracle: Environments, Economies and Geopolitics in the History of Europe and Asia (2nd Edition). Cambridge: Cambridge University Press.

Jouguet, P.
1901 "Fouilles du Fayoum. Rapport sur les fouilles de Medinet-Madi Ghoran" Bulletin de correspondance hellenique 25:379-411.

al Kady, M.
1979 "On Farm Water Management in Egypt" Ph d. dissertation. Ein Shams University. Cairo, Egypt.

Kamil, Jill
1987 Coptic Egypt: History and Guide. Cairo: American University Press.

al-Katsha, Samiha et a.
1989 Women, Water, and Sanitation: Household Water Use in Two Egyptian Villages. Cairo Papers in the Social Sciences Vol. 12 Monograph 2, Summer 1989.

Keenan, James G.
1969 "Ten Dike Certificates from Tebtunis" Bulletin of the American Society of Papyrologists 6:119-129.

1989 "Pastoralism in Roman Egypt" Bulletin of Society of Papyrolgoists 26:175-200.

Kees, Herman
1961 Ancient Egypt: A Cultural Topography. Chicago: University of Chicago Press.

Keldani, E. H.
1941 A Bibliography of Geology and Related Sciences Concerning Egypt Up to the End of 1939. Cairo: Government Press.

Kelly, William W.
1983 "Concepts in the Anthropological Study of Irrigation" American Anthropologist 85:880-886.

Kemp, Barry
1977 "An Incised Sherd from Kahun Egypt" Journal of Near Eastern Studies 36:289-292.

1983 "Old Kingdom, Middle Kingdom and Second Intermediate Period c. 2686-1552 BC" In Ancient Egypt: A Social History. B. Trigger, B. Kemp, D. O'Connor & A. Lloyd, eds. Pp. 71-182. Cambridge: Cambridge University Press.

1989 Ancient Egypt: An Anatomy of a Civilization. London: Routledge.

Kepel, Gilles
1984 Muslim Extremism in Egypt: The Prophet and Pharaoh. Berkeley: University of California Press. [English translation of: Le Prophete et Pharaaon (1984) Paris: Editions la De'couverte].

al Khachab, Abd El Mohsen
1978 A Sakha et au Fayum ou Les Bains Therapeutiques. Le Caire: Supplement Aux Annales Du Service des Antiquites De'LEgypt Cahier No. 25.

Khalidi, Tarif (ed.)
1984 Land Tenure and Social Transformation in the Middle East. Beirut: American University of Beirut.

al Khasab, Bahr
1974 "Review of the Early Tertiary Eutherian Faunas of African Mammals in Fayum Province Egypt" Annals of the Geological Survey of Egypt 4:95-114.

Khater, E. A.
1973 "Pedological Studies on Fayoum Governorate" Master's Thesis. Cairo University.

Khazanov, K. M.
1984 Nomads and the Outside World. Cambridge: Cambridge University Press.

Khedival Agricultural Society
1910 Yearbook of Khedival Agricultural Society 1909. Glasgow: Robert Maclehose and Co.

al Khule, Hasan
1982 Al Reef wa al Madenah fe Kujram'at al 'alam al thalath. Cairo: Dar al ma'arf.

Kincaid, C. A.
1969 Successors of Alexander. Chicago: Ares.

King, W. J. Harding
1925 Mysteries of the Libyan Desert: A Record of Three Years of Exploration in the Heart of that Vast Waterless System. London: Healey.

Knop, Edward C., Sheila Knop, Mohamed S. Sallam & Mona el Kady
1982 "Social Dimensions of Egyptian Irrigation Patterns" Egypt Water Use and Management Project Technical Report No. 26.

Kozlowski, J. K. (ed.)
1983 Qasr el-Sagha 1980: Contributions to the Holocene Geology, the Predynastic and Dynastic Settlements in the Northern Fayum Desert. Universitas Iagellonica Acta Scientiarum Litterarumague DCCIV, Schedae Archaeologicae 35 Warsaw.

Kolzlowski, Janusz K. & Ginter Boleslaw
1984 "The Fayum Neolithic in the Light of New Discoveries" Recherches Archeologique de 1984. Pp. 84-99. Krakow: l'Institut d'Archeologie de Universite de Cracovie.

Krader, Lawrence
1972 "The Work of Marx and Engels in Ethnology Compared" International Review of Social History 18(2)68-77.

1975 The Asiatic Mode of Production: Sources, Development and Critique in the Writing of Karl Marx. The Netherlands: Van Gorcum & Company.

Krader, Lawrence (ed.)
1973 The Ethnological Notebooks of Karl Marx (Studies of Morgan, Phear, Maine, Lubbock. Assen, The Netherlands: Van Gorcum.

Kurtz, R. V.
1984 "Legitimation and the Aztec State" Ethnology 23(4):301-314.

Lacey, W. K.
1968 The Family in Classical Greece. Ithaca: Cornell University Press.

Landau, Jacob M.
1965 "Prolegomena to a Study of Secret Societies in Modern Egypt" Middle Eastern Studies I:1-52.

Landes, David S.
1958 Bankers and Pashas. Cambridge: Harvard University Press.

1980 Bankers and Pashas: International Finance and Economic Imperialism in Egypt. Cambridge: Harvard University Press.

Lane, Edward W.
1835 The Manners and Customs of the Modern Egyptians. London: Charles Knight.

Lane, Mary Ellen
1985 Guide to The Antiquities of the Fayoum. Cairo: American University in Cairo Press.

Lane-Poole, Stanley
1901 [1969] A History of Egypt in the Middle Ages. New York: Haskell House.

Lansing, J. Stephen
1987 "Balinese 'Water Temples' and the Management of Irrigation" American Anthropologist 89(2):326-341.

1991 The Priests and Programers: Technologies of Power in the Engineered Landscape of Bali. Princeton: Princeton University Press.

Lanzone, Ridolfo Vittorio
1896 Les Papyrus du lac Moeris. Turin: Bocca freres.

Lasken, Jesse E.
1990 "The Location of the Labyrinth" Newsletter of the American Research Center in Egypt 152:3-5.

Lapidus, Ira M.
1967 Muslim Cities of the Later Middle Ages. Cambridge: Harvard University Press.

Larson, Barbara K.
1982 "The Structure and Function of Village Markets in Contemporary Egypt" Journal of the American Research Center in Egypt 19:131-144.

Lascaris, P.
1914 "Agriculture du Fayoum" Bulletin de la Societe Royale de Geographie d'Egypte 12 eme annee Nov. Pp. 257-261.

Laslett, Peter
1971 The World We Have Lost: England Before the Industrial Revolution. Second Edition. New York: Charles Scribner's Sons.

Laufer, B.
1933 "The Noria or Persian Wheel" In Oriental Studies in Honor of Cursetji Erachji Pavry. Jal Dastur Cursetji Pavry, ed. Pp. 210-235. London: Oxford University Press.

Lawless, Robert
1977 Societal Ecology in Northern Luzon: Kalinga Agriculture, Organization, Population, and Change. Papers in Anthropology. Volume 18. Number 1. Norman, Oklahoma: University of Oklahoma.

Leach, Edmund
1959 "Hydraulic Society in Ceylon" Past and Present Pp. 2-26.

1961 Pul Eliya. Cambridge: Cambridge University Press.

Leahy, Anthony
1988 Libya and Egypt in the First Millennium B.C. London: Croom Helm.

Leacock, Eleanor
1972 "Introduction" to Frederick Engles 1884, The Origin of the Family, Private Property and the State. Pp. 7-67, New York: International Publishers.

Leeder, S. H.
1918 Modern Sons of Pharaohs, A Study of the Manners and Customs of the Copts of Egypt. London: Hodder & Stoughton.

Lees, Susan
1986 "Coping with Bureaucracy: Survival Strategies in Irrigated Agriculture" American Anthropologist 88(3):610-622.

1989 "On Irrigation and the Conflict Myth" Current Anthropology 30(3):343-344.

Lenoir, Paul,
1872 Le Fayoum, le Sinai et Petra. Paris: PLR.

Lesko, Leonard H.
1982 "Excavation Report: Seila in the Fayum, 1981" American Journal of Archaeology 86(2):275.

Lewin, Gunter
1981 "Wittfogel on the Asiatic Mode of Production" In The Asiatic Mode of Production. A. M. Bailey & J.R. Llobera, eds. Pp. 158-163. London: Routledge and Kegan Paul.

Lewis, Bernard
1970 "Egypt and Syria" In The Cambridge History of Islam. P.M. Holt, A.K.S. Lamberton & B. Lewis, eds. Pp. 175-230. Cambridge: Cambridge University Press.

Lewis, Naphtali
1983 Life in Egypt Under Roman Rule. Oxford: Clarendon Press.

1986 Greeks in Ptolemaic Egypt: Case Studies in the Social History of the Hellenistic World. Oxford: Clarendon Press.

Lief, Louise
1991 "'There is No Torture in Egypt': A Spiral of Violence" U.S. News & World Report January 21. Pp. 24.

Liernur, G. A.
1888 The Wady Rayan Survey. Cairo: Ministry of Public Works.

Little, O. H.
1936 "Recent Geological Work in the Faium and the Adjoining Portion of the Nile Valley" Bulletin de l'Institut d'Egypte 18:14-27.

Lloyd, Alan B.
1983 "The Late Period, 664-323 BC" In Ancient Egypt: A Social History. Trigger, B. G., B. J. Kemp, D. O'Connor & A. B. Lloyd, eds. Pp. 279-348. Cambridge: Cambridge University Press.

Lucas, A.
1902 Preliminary Investigation of the Soil and Water of the Fayum. Cairo: Government Survey Department.

MacKenzie, Micahel
1985 "A Note on Motivation and Future Generations" Environmental Ethics 7(1):63-69.

Malagodi, E. F. & Kevin Jackson
1989 "Behavior Analysts and Cultural Analysis: Troubles and Issues" The Behavior Analyst 12(1):17-33.

Manning, Joseph G.
1990 "The Transfer of Landed Property in Upper Egypt in the Ptolemaic Period" Newsletter of the American Research Center in Egypt 152:1-3.

Marsot, Afaf Lutfi al-Sayyid
1984 Egypt in the Reign of Muhammad Ali. Cambridge: Cambridge University Press.

Marx, Karl
1853a "The British Rule in India" New York Daily Tribune No. 3804, June 25 1853. Reprinted in 1969 Karl Marx and Frederick Engels Selected Works. 1:487-493.

1853b "The Future Results of British Rule in India" New York Daily Tribune August 8, 1853. Reprinted in 1969 Karl Marx and Frederick Engels Selected Works. 1:494-499.

1858 [1965] Pre-capitalist Economic Formations. J. Cohen Trans. New York: International Publishers.

1939 Grundrisse. Notes and translation by Martin Nicolaus. New York: Vintage.

1959 A Contribution to the Critique of Political Economy. [1970] Translated, edited by Maurice Dobb. New York: International Publishers.

Maass, Arthur & Raymond L. Anderson
1978 ...And the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments. Cambridge, Massachusetts: MIT Press.

al Matamr al Jagra fe al 'arab al awal
1962 Al Fayoum. Cairo: al-hadi.

McBurney, C.B.M.
1967 The Haua Fteah (Cyrenaica) and the Stone Age of the South-East Mediterranean. Cambridge: Cambridge University Press.

McNeill, William H.
1976 Plagues and People. Garden City: Anchor Press.

Mehanna, Sohair, Richard Hunnington & R. Antonius
1984 Irrigation and Society in Rural Egypt. Cairo Papers in the Social Sciences Vol 7, No. 4.

Mehringer, Peter J. Kenneth L. Peterson & Fekri Hassan
1979 "A Pollen Record from Birket Qarun and the Recent History of the Fayum" Quaternary Research 11:238-256.

Meinardus, Otto
1977 Christian Egypt, Ancient and Modern. 2nd ed. Cairo: American University Press.

Meissner, Jeffery
1986 "Tribes at the Core." Ph. D. dissertation, Columbia University.

Mendelsohn, Isaac
1949 Slavery in the Ancient Near East. New York: Holm.

Mendelssohn, Kurt
1971 "A Scientist Looks at the Pyramids" American Scientist 59:210-220.

Menghin, Oswald & Kurt Bittel
1934 "Kasr el-Sagha" Mitteilungen des Deutschen Instituts Fur Agyptische Altertumskunde in Kiaro 5:1-10.

Messick, Brinkley
1978 "Transactions in Ibb." Ph. D. dissertation. Princeton University. Ann Arbor: University Microfilms.

Michalski, Ireneusz
1964 "Remarks About the Anthropological Structure of Egypt" Publication of the Joint Arabic-Polish Anthropological Expedition Pt. II. Pp. 209-231. Warsaw: Government Press Office.

Miller, David H.
1977 Water at the Surface of the Earth. New York: Academic Press.

Milliot, Louis
1953 Introduction a l'Etude du Droit Musulman. Paris: Recueil Sirey.

Mitchell, Tim
1988 Colonizing Egypt. Cambridge: Cambridge University Press.

1991 "America's Egypt: Discourse of the Development Industry" Middle East Report No. 169:18-36.

Mitchell, William P.
1985 "On Terracing in the Andes" Current Anthropology 26(2):288-289.

1991 Peasants on the Edge: Crop, Cult and Crisis in the Andes. Austin: University of Texas Press.

Mitwalli, M.
1952 "History of the Relations Between the Egyptian Oases of the Libyan Desert and the Nile Valley" Bulletin Institute au Desert 2:114-131.

Mohammed, Mohammed el Said
1944 "The Structure and Function of Agricultural Export Trade in the Egyptian Economy" Ph D. dissertation. University of California Berkeley.

Moncrieffe, Scott
1886 Note on the Corvee in Egypt. Cairo: National Printing Office.

Moore, M. P.
1980 Approaches to Improving Water Management on Large-scale Irrigation Schemes in Sri Lanka. Columbo: Government Press.

Moriah, Gabriel
1963 "The Social Structure of the Sufi Associations in Egypt in the 18th Century" Ph D. dissertation. University of London.

Morritz, B.
1899 "Description du Fayoum au VII eme siecle de l'Hegire" Publication de la Bibliotheque Khediviale 6:214.

Morsy, Soheir A.
1986 "U.S. Aid to Egypt: An Illustration and Account of U.S. Foreign Assistance Policy" Arab Studies Quarterly 8(4):358-389.

Moussly, Nazim
1951 Le probleme de l'eau en Syrie. Lyon: Impr. Bosc freres.

Moustafa, Y. Shawki
1974 "Critical Observations on the Occurrence of Fayum Fossil Vertebrates" Annals of the Geological Survey of Egypt 4:41-78.

Murphey, Rhoads
1974 "The Ruin of Ancient Ceylon" Journal of Asian Studies 16:181-200.

Murphy, Robert F.
n.d. "Types of Irrigation and their Developmental Implications" unpublished ms.

Murray, G.W.
1935 Sons of Ishmael. London: George Routledge & Sons Ltd.

al-Murtadaa
1392 [1938] kitab al Azhar fi Fiqh al Imma al Athar. Beirut: Sabad.

Mussi, M., I. Caneva & A. Zarattini
1984 "More on the Terminal Paleolithic of the Fayum Depression" In Origin and Development of Food-Producing Cultures in North-Eastern Africa. L. Krzyzaniak and Kobusiewicz, eds. Pp. 184-198. Poznan: Poznan Archaeology Museum.

Nabulsi, Uthman b. Ibrahim
1958-1960 [Becker, C. & C. Cahen, Editors] Kitab luma' al-qawanin al mudiyya. in Bulletin d'etudes Orientales XVI.

Nasif, Nasif Mohamed
1970 "Internal Migration and Population Growth in Fayoum Governate" Paper of the General Diploma in Demography, Cairo: C.D.C.

Nassar, Saad, Ragaa el Amir & Abd el Azeem Moustafa
1981 "Determinants of Agricultural Price Policy in Egypt, Agricultural Development Systems Project" Economic Working Paper No. 50. Cairo: United States Agency for International Development.

Nasser, Gamal Abdel
1959 The Philosophy of the Revolution. Buffalo: Economica Books.

Nassery, S.A.A. (el-Nassery), G. Wagner & G. Castel
1976 "Un Grand Bain Greco-Romain a Karanis" Bulletin de l'Institute Francais d'Archeologie Orientale 76:232.

Needham, Joseph
1965 Science and Civilization in China. Volume 4, Part 2. Cambridge: Cambridge University Press.

Neilson, J.
1903 "Flint Implements From the Fayum Egypt" Geological Magazine London 10:192.

Netting, Robert
1974 "The System Nobody Knows: Village Irrigation in the Swiss Alps" In Irrigation's Impact on Society. Downing and Gibson, eds. Pp. 48-62 Tucson: University of Arizona Press.

Noth, Albrecht
1984 "Some Remarks on the 'Nationalization' of Conquered Lands at the time of the Umayyads" In Land Tenure and Social Transformation in the Middle East. T. Khalidi, ed. Pp. 223-228. Beirut: American University Beirut Press.

Oates, John F.
1965 "The Evidence of Egypt" Bulletin of the American Society of Papyrologists 2(2):57-64.

O'Brien, Patrick K.
1988 "The Costs and Benefits of British Imperialism 1846-1914" Past and Present 120:162-200.

O'Connor, David
1983 "New Kingdom and Third Intermediate Period, 1552-664 BC" In Ancient Egypt: A Social History. Trigger, B. G., B. J. Kemp, D. O'Connor & A. B. Lloyd, eds. Pp. 183-278. Cambridge: Cambridge University Press.

Oleson, J. P.
1984 Greek and Roman Mechanical Water Lifting Devices: The History of a Technology. Toronto: Royal Ontario Museum.

Owen, Edward R.J.
1969 Cotton and the Egyptian Economy, 1820-1914: A Study in Trade and Development. Oxford: Clarendon Press.

Palmer, Monte, Ali Leila & el Sayed Yassin
1989 "Bureaucratic Innovation and Economic Development in the Middle East: A Study of Egypt, Saudi Arabia and the Sudan" Journal of Asian and African Studies XXIV(1-2):12-27.

Parassoglou, George
1972 "Imperial Estates in Egypt" Ph. D. dissertation, Yale University.

Park, Thomas K.
1992 "Early Trends Toward Class Stratification: Chaos, Common Property, and Flood Recession Agriculture" American Anthropologist 94(1):90-117.

Pasternak, B.
1968 "Social Consequences of Equalizing Irrigation Access" Human Organization 27:332-342.

Pearl, O. M.
1951 "Irrigation Works and Canals in the Arsinoite Nome" Aegyptus 31:223-230.

Pearson, Birger A. & James E. Goehring
1986 The Roots of Egyptian Christianity. :Fortress.

Peet, Richard
1981 "Historical Forms of the Property Relation: A Reconstruction of Marx's Theory" Antipode 13(3):13-25.

1985 "Introduction to the Life and Thought of Karl Wittfogel (With an Appendix on the Asiatic Mode of Production)" Antipode 17(1):3-20.

Pestman, P. W.
1961 "Marriage and Matrimonial Property in Ancient Egypt: A Contribution to Establishing the Legal Position of the Woman" Papyrologica Lugduno-Batava 9. Leiden.

Petrie, William Matther Flinders
1891 Illahun, Kahun and Gurob. Warminster, England: Aris & Phillips.

1899 Hawara, Biahmu and Arsinoe. Warminster, England: Aris & Phillips.

1911 Roman Portraits and Memphis. Warminster, England: Aris & Phillips.

1926a "Early Egypt and the Fayum" Nature 118:696.

1926b "The History of the Fayoum Lake" Journal of the Royal Anthropological Institute of Great Britain and Ireland 56:325-326.

1926c "Observations on 'the Recent Geology and Neolithic Industry of the Northern Fayum' by Miss E. W. Gardner and G. Caton-Thompson" Journal of the Royal Anthropological Institute of Great 56:325-326.

1938 "The Meaning of the Fayum" Syro-Egypt 3:12-15.

Pfaffenberger, Bryan
1989 "Fetished Objects and Humanized Nature: Toward an Anthropology of Technology" Man 23:236-252.

1990 "The Harsh Facts of Hydraulics: Technology and Society in Sri Lanka's Colonialization Schemes" Technology and Culture 31(3):361-397.

Pfannenstiel, M.
1953 Das Quartarder Levante, II. Die Entstehung der Aegyptischen Oasendepressionen. Wiesbaden: F. Steiner.

Phillips, James L.
1971 "The Nile Valley Final Paleolithic and External Relations" Ph. D. dissertation, Southern Methodist University.

Phillips, W.
1948 "Recent Discoveries in the Egyptian Fayum and Sinai" Science 107:666-670.

Phillipson, David W.
1985 African Archaeology. Cambridge: Cambridge University Press.

Pochan, A.
1936 "Note sur le Sujet de la Gorge d'Illahoun, deversoire discute du Lac Moeris" Bulletin de l'Institut d'Egypte 18:131-136.

Poirer, Frank E.
1977 <u>Fossil Evidence: The Human Evolutionary Journey</u>. Second Edition, St. Louis.

Pomeroy, Sarah P.
1984 <u>Women in Hellenistic Egypt</u>. New York: Schocken.

Popper, W.
1951 <u>The Cairo Nilometer</u>. Berkeley: University of California Publications in Semitic Philology Number 12.

Postel, S.
1992 <u>Last Oasis: Facing Water Scarcity</u>. New York: Norton.

Prentis, E. M.
1985 "The Role of Women in Vegetable Production in Fayoum Governorate" <u>Horticulture Demonstration and Extension Station Project Technical Paper</u>. The Hague: HDES Project (P.O. Box 20061, 2500 EB The Netherlands).

Price, Barbara
1977 "Shifts in Production and Organization" <u>Current Anthropology</u> 18:209-233.

1981 "Irrigation: Sociopolitical Dynamics and the Growth of Civilization" In <u>The Asiatic Mode of Production: Science and Politics</u>. A. Bailey & J. Llobera, eds. Pp. 216-232. London: Routledge and Kegan Paul.

Price, David H.
1988 "Reply to Romney, Weller and Batchelder" <u>American Anthropologist</u> 90(1):159-161.

el Quosy, Dia el din & Samia el Guindi
1981 <u>Re-Use of Drainage Water For Agricultural Purposes in Fayoum</u>. (UNDP-EGY/81/031/A/01/42) Cairo: Drainage Research Institute Water Research Center, Ministry of Irrigation.

Rabie, Hassanein
1972 <u>The Financial System of Egypt: A.H. 564-741/ A.D. 1169-1341</u>. London: Oxford University Press.

Radvan, Samir
1977 <u>Agrarian Reform and Rural Poverty, Egypt, 1952-1975</u>. Geneva: International Labor Office.

al-Rafi'i, Abd al-Rahman
1914 Niqabat al-ta'awun al-ziraiya, nizamuha wa tarikuha wa thamarathuha fi misr was utuba. Cairo: al Nahda al-Ababiya Press.

Ragib, Yusuf
1982 Marchands d'etoffes du Fayyoum. Le Caire: Institut Francais d'archeologie orientale.

Ralph, E.K., H.N. Michael & M. C. Han
1973 "Radiocarbon Dates and Reality" MASC Newsletter 9:1-20.

Ramzi, Muhammad (ed.)
1960 al-qamus al-jiyugrafi lil-balad al-misriyya. Cairo: Dar al-Kutub.

Rathbone, Dominic
1991 Economic Rationalism and Rural Society in 3rd Century A.D. Egypt: The Heroninos Archive and the Appianus Estate. New York: Cambridge University Press.

Rawlinson, George
1886 History of Ancient Egypt Volume II. New York: John B. Alden.

Rawson, Beryl
"The Roman Family" In The Family in Ancient Rome. B. Rawson, ed. Pp. 1-57. Ithaca: Cornell University Press.

Redman, Charles L.
1978 The Rise of Civilization: From Early Farmers to Urban Society in the Ancient Near East. San Francisco: Freeman.

Reidinger, Richard B.
1974 "Institutional Rationing of Canal Water in Northern Indian: Conflict Between Traditional Patterns and Modern Needs" Economic Development and Cultural Change 23(1):79-104.

Replogle, J. A. & A. J. Clemmens
1979 "Broad-crested Weirs for Portable Flow Metering" Transactions of the American Society of Agricultural Engineers 22(6):1324-1328.

Reynolds, Terry S.
1983 Stronger Than A Hundred Men: A History of the Vertical Water Wheel. Baltimore: Johns Hopkins University Press.

Richards, Alan R.
1975 "Accumulation, Distribution and Technical Change in Egyptian Agriculture 1800-1940" Ph. D. dissertation, University of Wisconsin.

1977 "Primitive Accumulation in Egypt: 1798-1882" Review 1(2):3-49.

1979 "The Political Economy of Gutswirtschaft: A Comparative Analysis of East Elbian Germany, Egypt, and Chile" Comparative Studies in Society and History 21(4):483-518.

1982 Egypt's Agricultural Development, 1800-1980: Technological and Social Change. Boulder: Westview Press.

Rivilin, H. A. B.
1961 The Agricultural Policy of Muhammed 'Ali in Egypt. Cambridge: Harvard University Press.

Ross, Justin C.
1893 "Irrigation and Agriculture in Egypt" The Scottish Geographical Journal Magazine 9:169-193.

Rostovtzeff, M.
1922 A Large Estate in Egypt in the 3rd Century B.C.: A Study in Economic History. Univ. Of Wisconsin Studies in the Social Sciences and History, No. 6. Madison: University of Wisconsin Press.

1928,/1929. "Roman Exploitation of Egypt in the First Century A.D." Journal of Economic and Business History 1:377-397.

Russell, Kenneth W.
1988 After Eden: The Behavioral Ecology of Early Food Production in the Near East and North Africa. London: British Archaeological Reports Series No. 391.

Ryan, Bryce
1953 Caste in Modern Ceylon: The Sinhalese System in Transition. New Brunswick: Rutgers University Press.

Saab, Gabriel S.
1967 The Egyptian Agrarian Reform: 1952-1962. London: Oxford University Press.

Saad, Reem
1988 "Social History of an Agrarian Reform Community in Egypt" Cairo Papers in the Social Sciences 11(4) Winter.

Sadowski, Yahya M.
1991 Political Vegetables? Businessman and Bureaucrat in the Development of Egyptian Agriculture. Washington, DC: Brookings Institute.

Sahal abdu alhleer 'asba
1984 Tanmeet wa takhteet almastwtnat al reef. Cairo: Maktabh al nhst al misreh.

Sahlins, Marshall & Elman Service (eds.)
1960 Evolution and Culture. Ann Arbor: University of Michigan Press.

Said, Rushdi
1962 The Geology of Egypt. Amsterdam: Elsevier Publishing Company.

1981 The Geological Evolution of the River Nile. New York: Springer.

Said, Rushdi, C. Albritton, F Wendorf, R. Schold & M. Kobusiewicz
1972a "Remarks on the Holocene Geology and Archaeology of Northern Fayoum Desert" Archaeologia Polona 13:7-22.

1972b "A Preliminary Report on the Holocene Geology and Archaeology of the Northern Fayum Desert" In Playa Lake Symposium. C.C. Reves Jr., ed. Pp. 41-61. Lubbock: Icasals Publication No. 4.

Sallers, Robert
1991 The Ecology of the Ancient Greek World. Cornell, New York: Cornell University Press.

Salmon, G.
1901 "Ketab Tareekh al-Fayoum d'apres an Nabulsi" Bulletin de l'Institut Francais d'Archeologie Oriental 1:1-24.

Salmon, M. Georges
1901a "Note sur la Flore du Fayyoum d'Apres an-Nabulsi" Bulletin de l'institut Francais d'Archeologie Orientale du Caire 1:25-28.

1901b "Repertoir Geographique de la Province du Fayyoum d'apres le kitab Tarikh al-Fayyoum d'an-Naboulsi" Bulletin de L'institut Francais d'archeologie Orientale du Caire 1:29-77.

Samuel, A. E.
1968 "The Greek Element in the Ptolemaic Bureaucracy" Proceedings of the XIIth International Papyrology Congress 12:443-453.

Samuel, Deborah H.
1977 "Taxation at Socnopaiou Nesos in the Early Third Century" Bulletin of the American Society of Papyrologists 14(4):161-207.

Sanders, William T. & David Webster
1988 "The Mesoamerican Urban Tradition" American Anthropologist 90(3):521-546.

Sanderson, Stephen K.
1990 Social Evolutionism: A Critical History. Cambridge: Blackwell.

Sandford, K. S. & W. J. Arkell
1928 "The Relation of Nile and Fayoum in Pliocene and Pleistocene Times" Nature 121:670-671.

1929 Prehistoric Survey of Egypt and Western Asia: Paleolithic Man and the Nile-Fayoum Divide. Chicago: Oriental Institute Publication 10.

Saunders, Lucie Wood & Soheir Mehanna
1986 "Village Entrepreneurs: An Egyptian Case" Ethnology 25(1):75-88.

Sawer, Marian
1977 Marxism and the Question of the Asiatic Mode of Production. The Hague: Martinus Nijhoff.

Schienerl, Peter W.
1976 "Die gebrauchlichsten schmuckformen in der oase fayoum (agypten). Acta Ethnographica Academiae Scientarium Hungarcae 25(3-4):297-320.

Schild, Romuald
1987 "Unchanging Contrast? The Nile and the Sahara" In Prehistory of Arid North Africa. A. Close, ed. Pp. 13-27. Dallas: Southern Methodist University Press.

Schild, Romuald & Fred Wendorf
1981 The Prehistory of an Egyptian Oasis. Warsaw: Zaklad Narodowy im Ossoli'nskich.

Schioler, Thorkild
1973 Roman and Islamic Water-Lifting Wheels. Odense, The Netherlands: Odense University Press.

Scott-Moncrieff, P. D.
1913 Paganism and Christianity in Egypt. Cambridge: Cambridge University Press.

Sebring, James M.
1987 "Bovidicy" Journal of Anthropological Research 43:309-319.

Seton-Karr, Haywood Walter
1898 "Discovery of the Lost Flint Mines of Egypt" Journal of the Royal Anthropological Institute of Great Britain and Ireland 7:90-92.

1904a "Stone Implements of the Fayum, Egypt" Annual Report, Smithsonian Institution 747-751.

1904b "Fayoom Flint Implements" Annals du service des Antiquites de l'Egypte 5:145-186.

1905 "Discovery of a Neolithic Settlement in the Western Desert North of the Fayum" Annals du service des Antiquites de l'Egypte 6:185-187.

1907 "Instruments en Pierre du Fayum" L'Homme Prehistorique 5:263-272.

Shafei, Ali
1940a Rie al Fayoum kama wa safahu al Nabulsi Sanat 643 Hijarah. Cairo: al haleya.

1940b "Fayoum Irrigation As Described by Nabulsi in 1245 A. D. With A Description of the Present System of Irrigation and a Note on Lake Moeris" Bulletin de la Societe Geographique Royal de egypte 20(3):283-327.

1960 "Lake Moeris and Lahun Mi-wer and Ro-hun: The Great Nile Control Project Executed by the Ancient Egyptians" Societe d'Egypte Bulletin 33:187-215.

Shaw, Stanford
1958 The Financial Administrative Organization and Development of Ottoman Egypt, 1517-1789. London: Oxford University Press.

1968 "Landholding and Land-Tax in Ottoman Egypt" In Political And Social Change in Modern Egypt. P. M. Holt, ed. London: Oxford University Press.

al-Shaziy, E. M., M. A. Abdel Hady, M. A. el Ghawaby & S. Khawasik
1976 NASA LANDSAT G-27930, Regional Prospecting for Iron Ores in Bahariya Oasis el Faiyum Area Egypt, Using Landsat Satellite Images. Cairo: Remote Sensing Center Academy of Science Research & Technology.

Shier, Louise A.
1978 Terracotta Lamps From Karanis, Egypt. The Keksey Museum of Archaeology Studies No. 3., Ann Arbor: University of Michigan Press.

Shorter, Frederic
1989 "Cairo's Leap Forward: People, Households and Dwelling Space" Cairo Papers in the Social Sciences 12(1), Spring.

Sijpesteijn, P. J. & K. A. Worp
1979 "Six Dike Certificates" Bulletin of the American Society of Papyrologists 16:131-135.

Simons, E. L., P. Andrews & D. R. Pilbeam
1978 "Cenozoic Apes" In The Evolution of African Mammals. V. J. Maglio & H. B. S. Cooke, eds. Pp. 120-146. Cambridge, Massachusetts: Harvard University Press.

Simons, Wlwyn L. & Tab D. Rasmussen
1990 "Vertebrate paleontology of Fayum: History of Research, Faunal Review and Future Prospects" In The Geology of Egypt. Said Rushdi, ed. Pp. 627-638. Rotterdam: A.A. Balkema.

Simons, E. & A. Wood
1968 "Early Cenzoi Mamalian Faunas, Fayum Province, Egypt" Peabody Museum of Natural History Bulletin 28:1-105.

Singer, Charles, E. J. Holmyard & A. R. Hall (eds.)
1954 A History of Technology. Oxford: Clarendon Press.

Skinner, B. F.
1981 "Selection by Consequence" Science 213:501-504.

1986 "Why We are Not Acting to Save the World" Chapter One in, Upon Further Reflection. New York: Prentice Hall.

Skold, Melvin D., S. el-Shinnawi & M. Lofty Nasr
1984 "Irrigation Water Distribution Along Branch Canals in Egypt: Economic Effects" Economic Development and Cultural Change 32:547-567.

Smith, F. L.
1921 "The Egyptian 'Norag' and its Origin." Bulletin de la Societe Sultanieh de Geographie Volume 10.

Smith, Norman
1975 Man and Water. New York: Scribner.

Smith, R. T.
1989 "Water Transfers, Irrigation Districts and the Compensation Problem" Journal of Policy Study and Management 8:446-465.

Smith, Thomas C.
1959 The Agrarian Origins of Modern Japan. Palo Alto: Stanford University Press.

Sneh, A. & T. Weissbroad
1973 "Nile Delta: The Defunct Pelusiac Branch Identified" Science 180:59-61.

Sneh, A., T. Weissbroad, & I. Perath
1975 "Evidence for an Ancient Egyptian Frontier Canal" American Scientist 63:542-548.

Sowson, E. M. and J. I. Craig
1910 Collection of Statistics of the Areas Plated in Cotton in 1909. Survey Department, Publication No. 21. Cairo: National Printing Office.

Spalinger, Anthony J.
1983 Aspects of the Military Documents of the Ancient Egyptians. Near Eastern Research Series No. 9. New Haven: Yale University Press.

Spencer, J. E. & G. A. Hale
1961 "The Origin, Nature and Distribution of Agricultural Terracing" Pacific Viewpoint 2:1-40.

Springborg, Robert
1991 "State-Society Relations in Egypt: The Debate Over Owner-Tenant Relations" Middle East Journal 45(2):232-249.

Stahl, John
1989 "Power Dynamics During the Rise of the State: An Application of the Rasch Model to Archaeological Data. (2 Volumes)." Ph.D. dissertation, Northwestern University.

Stanley, Daniel Jean & Andrew G. Warne
1993 "Nile Delta: Recent Geological Evolution and Human Impact" Science April 30, 260:628-634.

Steindorf, Georg & Keith C. Seele
1942 When Egypt Ruled the East. Chicago: University of Chicago Press.

Stevens, J. M.
1975 "Gynaecology from Anccient Egypt: the Papyrrus Kahun. A Translation of the Oldest Treatise on Gynaecology, that has Survived from the ancient World" Medical Journal of Australia 2:949-952.

Strabo
1932 The Geography of Strabo. Book 17. (translated by Leonard Jones), Cambridge: Harvard University Press, Loeb Classical Library.

Tackholm, Vivi
1974 Students' Flora of Egypt. Second Edition. Beirut: Cooperative Printing Company.

Tattersall, Ian, Eric Delson & John van Couvering
1988 "Fayoum" in Encyclopedia of Human Evolution and Prehistory. New York: Garland.

Tcherikover, Victor A. & Alexander Fuks (eds.)
1957 Corpus Papyrorum Judaicarum, Volume 1. Cambridge: Harvard University Press.

1960 Corpus Papyrorum Judaicarum, Volume 2. Cambridge: Harvard University Press.

1964 Corpus Papyrorum Judaicarum, Volume 3. Cambridge: Harvard University Press.

Thomas, A. P.
1981 "Gurob: A New Kingdom Town. Introduction and Catalogue of Objects in the Petrie Collection" Egyptology Today no. 5, Vol. 1.

Thompson, Dorthy J.
1984 "Agriculture", In Cambridge Ancient History Pp. 363-383, Cambridge: Cambridge University Press.

1990 "The High Priests of Memphis under Ptolemaic Rule" In Pagan Priests: Religion and Power in the Ancient World. Mary Beard & John North, eds. Pp. 97-116. London: Duckworth.

Thompson, Herbert M. (ed)
1983 Studies in Egyptian Political Economy. Cairo Papers in the Social Sciences Vol 2 Number 3.

Tignor, Robert L.
1963 "British Agricultural and Hydraulic Policy in Egypt, 1882-1892" *Agricultural History* 37(2):63-74.

1966 *Modernization and British Colonial Rule In Egypt, 1882-1914*. Princeton: Princeton.

1989 *Egyptian Textiles and British Capital: 1930-1956*. Cairo: American Univeristy in Cairo Press.

Tollefson, H. H.
1990 "The 1894 British Takeover of the Egyptian-Ministry-of-Interior" *Middle East Studies* 26(4):547-560.

Topel, Lori Reed
1973 "Studies in the Administrative and Economic History of Tebtunis in the First Century A.D." Ph. D. dissertation, Duke University.

Toth, James
1991 "Pride, Purdah, or Paychecks: What Maintains the Gender Division of Labor in Rural Egypt" *International Journal of Middle East Studies* 23(2):213-236.

Trigger, Bruce G.
1983 "The Rise of Egyptian Civilization" In *Ancient Egypt: A Social History*. Trigger, B. G., B. J. Kemp, D. O'Connor & A. B. Lloyd, eds. Pp. 1-70. Cambridge: Cambridge University Press.

Trigger, B. G., B. J. Kemp, D. O'Connor & A. B. Lloyd (eds.)
1983 *Ancient Egypt: A Social History*. Cambridge: Cambridge University Press.

Tucker, Judith E.
1985 *Women in Nineteenth-Century Egypt*. Cambridge: Cambridge University Press.

Tufnell, O.
1975 "Seal Impressions from Kahun Town and Uronarti Fort: A Comparison" *Journal of Egyptian Archaeology* 61:67-101.

Turner, B. L. II
1989 "The Rise and Fall of Population and Agriculture in the Central Maya Lowlands: 300 B.C. to Present" In *Hunger in History: Food Shortage, Poverty & Deprivation*. L. Newman, ed. Pp. 179-211. New York: Basil Blackwell.

Turner, Bryan S.
1984 Capitalism and Class in the Middle East: Theories of Social Change and Economic Development. London: Heinemann Educational Books.

Turner, E. G.
1984 "Ptolemaic Egypt" In The Cambridge Ancient History, Vol. VII, Pt 1: The Hellenistic World. F. W. Walbank & A. Astin eds. Pp. 118-174. Cambridge: Cambridge University Press.

Ulmen, G. L.
1978 The Science of Society: Toward an Understanding of the Life and Work of Karl August Wittfogel. The Hague: Mouton Publishers.

United Nations
1982 "Proceedings of the Seminar on The Improvement of Irrigation Performance at the Project Level" New York: Water Resource Series #56.

Uphoff, N.
1990 "Optimum Participation in Irrigation Management: Issues and Evidence From Sri Lanka" Human Organization 49:26-40.

Vanderlip, Verra Frederika
1972 "The Four Hymns of Isidorus and the Cult of Isis." American Studies in Papyrology vol 12.

Vandermeer, Canute
1971 "Water Thievery in a Rice Irrigation System in Taiwan" Association of American Geographers Annals 61:156-179.

Varisco, Daniel
1982 "The Adaptive Dynamics of Water Allocation in Al-Ahjur, Yemen Arab Republic" Ph D dissertation, University of Pennsylvania.

Vatikiotis, P. J.
1985 The History of Egypt From Mohammad Ali to Mubarak. London: Weidenfeld and Nicolson.

Vermeersch, P. M., M. Otte, E. Grilot, G. Grijseling & D. Drappier
1982 "Blade Technology in the Egyptian Nile Valley" Science 249:626-628.

Wagstaff, J. M.
1985 The Evolution of Middle Eastern Landscapes: An Outline to A. D. 1840. Totowa, New Jersey: Barnes & Nobel.

Wainwright, G. A.
1940 "Cannibalism in Modern Egypt" Man 40:189

Walker, C. J.
1990 "Time For A New Look at Nasserism" Middle East International 2 Feb. 19-20.

Wallace, Sherman L.
1938 Taxation in Egypt From Augustus to Diocletian. New York: Greenwood.

Wallerstein, Immanuel
1979 The Capitalist World-Economy. Cambridge: Cambridge University Press.

Walters, C. C.
1974 Monastic Archaeology in Egypt. London: Aris & Phillips.

1989 "Christian Painting from Tebtunis" The Journal of Egyptian Archaeology 75:191-208.

Ward, William A.
1984 "Some Aspects of Private Land Ownership and Inheritance in Ancient Egypt, ca. 2500-1000 B.C." In Land Tenure and Social Transformation in the Middle East. T. Khalidi, ed. Pp. 63-77. Beirut: American University Beirut Press.

Warriner, Doreen
1962 Land Reform and Development in the Middle East: A Study of Egypt, Syria and Iraq. London: Oxford University Press.

Waterbury, John
1978 Egypt: Burdens of the Past, Options for the Future. Bloomington: Indiana University Press.

1979 Hydropolitics of the Nile Valley. Syracuse: Syracuse University Press.

1983 The Egypt of Nasser and Sadat: The Political Economy of Two Regimes. Princeton: Princeton University Press.

1990 "The Political Context of Public Sector Reform and Privatization in Egypt, India, Mexico and Turkey," In The Political Economy of Public Sector Reform and Privatization. In E. N. Suleiman & John Waterbury, eds. Pp. 293-318. Boulder: Westview.

Watkin, Edward
1963 A Lonely Minority: The Modern Story of Egypt's Copts. New York: William Morrow & Co.

Webb, Malcolm C.
1985 "The State of the Art of State Origins?" Reviews in Anthropology 11:170-281.

1988 "The First States: How--Or In What Sense--Did 'Circumscription' Circumscribe?" American Behavioral Scientist 31(4):449-458.

Weber, Max
1968 The Religion of China. New York: Free Press.

Weeks, Kent
1986 An Historical Bibliography of Egyptian Prehistory. Winona Lake, Indiana: Eisenbrauns.

Wendorf, Fred & Fekri Hassan
1980 "Holocene Ecology and Prehistory in the Egyptian Sahara" In The Sahara and the Nile. M. Williams & H. Fuare, eds. Pp. 407-419. Rotterdam: A. A. Balkema.

Wendorf, Fred & Romuald Schild
1976a Prehistory of the Nile Valley. New York: Academic Press.

1976b "Archaeology and Pleistocene Stratigraphy of the Northern Fayum Depression" In Prehistory of the Nile Valley. Wendorf & Schild, eds. Pp. 155-226. New York: Academic Press.

Wenke, Robert J.
1989 "Egypt: Origins of Complex Societies" Annual Review of Anthropology 18:129-155.

Wenke R, Paul Buck, John Hanley, M. Lane, Janet Long & Richard Redding
1983 "The Fayyum Archaeological Project: Preliminary report of the 1981 Season" American Research Center in Egypt Newsletter 122:25-40.

Wenke, Robert J. & Mary Ellen Lane
1982 "Preliminary Report on the Fayyum" Unpublished report at USAID Library, Cairo.

1981 "Fayum Expedition, 1981" Newsletter of the American Research Center in Egypt 116:22-25.

Wenke, R. J., J. E. Long. & P.E. Buck
1988 "The Epipaleolithic and Neolithic Subsistence and Settlement in the Fayyum Oasis of Egypt" Journal of Field Archaeology 15(1):29-51.

White, Leslie
1975 The Concept of Cultural Systems: A Key to Understanding Tribes and Nations. New York: Columbia University Press.

Whitehouse, Frederic Cope
1885 Le lac Moris et son emplacement, d'apr'es de nouvelles recherches. London: Harrison and Sons.

Wilkinson, J. C.
1978 "Islamic Water Law With Special Reference to Oasis Settlement" Journal of Arid Environments 1:87-96.

Willcocks, William
1904 The Assuan Reservoir and Lake Moeris: A Lecture Delivered at a Meeting of the Khedivial Geographical Society. London: E. & F. N. Spoon.

1917 "Le fellah et sa femme sur les terres incultes d'Egypte" Bulletin de Socciete de Geographie d'Egypte (n.s.) 8:167-188.

Willcocks, W. & J. L. Craig
[1899] 1913 Egyptian Irrigation. 2 vols. London: E. F. & N. Spoon.

Williams, M. A. J. & F. M. Williams
1980 "Evolution of the Nile Basin" In The Sahara and the Nile. M. Williams & F. Faure, eds. Pp. 207-224. Rotterdam: A. A. Balkema.

Wilson, J. A.
1955 "Buto and Hierakonpolis in the Geography of Egypt" Journal of Near Eastern Studies 14:209-236.

Winlock, Herbert E.
1934 The Treasure of El Lahun: Metropolitan Museum of Art. (Dept. of Egyptian Art Publications in Reprints). New York: Ayer Co Reprints 1972.

Wittfogel, Karl
1955 "Developmental Aspects of Hydraulic Societies" In Irrigation Civilizations: A Comparative Study. J. Steward, ed. Pp. 43-56. Washington, D. C.: Pan American Union.

1957 Oriental Despotism. New Haven: Yale University Press.

1967 "Book Review of Robert Mc Adams' 'The Evolution of Urban Society'" American Anthropologist 69(1)90-92.

1971 "Developmental Aspects of Hydraulic Societies" In Prehistoric Agriculture. Stuart Struever, ed. Pp. 557-571, Garden City, New York: The Natural History Press.

1985 "Geopolitics, Geographical Materialism, and Marxism" [translated by G. L. Ulmen] Antipode 17(1):21-72.

Woodbury, Richard
1961 "A Reappraisal of Hohokam Irrigation" American Anthropologist 63(3):550-560.

Worrell, William H.
1945 A Short Account of the Copts. Ann Arbor: University of Michigan Press.

Worsley, Peter
1984 The Three Worlds: Culture And World Development. Chicago: University of Chicago Press.

Worster, Donald
1979 Dust Bowl: The Southern Plains In the 1930s. Oxford: Oxford University Press.

1985 Rivers of Empire: Water, Aridity and the Growth of the American West. New York: Pantheon Books.

Yates, Robin D. S.
1989 "War, Food Shortages, and Relief Measures in Early China" In Hunger and History: Food Shortage, Poverty and Deprivation. Lucie Newman, ed. Pp. 147-177. New York: Basil Blackwell.

Zeki, Ahmed
1899 "Une description Arabe du Fayoum au VIleme Siecle de l'Hegire" Bulletin de la Societe Khedivale de Geographie Serie V: V. 253-295.

BIOGRAPHICAL SKETCH

David Price was born April 15, 1960 in Seattle Washington. He received his BA from The Evergreen State College, Olympia, Washington, in 1983 and his MA from the University of Chicago in 1985.

He has done archaeological and ethnographic fieldwork throughout the Middle East and the Pacific Northwest. He is the author of the book The Atlas of World Cultures: A Geographical Guide to Ethnographic Literature (1989, Sage). He currently lives in Olympia, Washington with his wife Midge and son Milo.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Marvin Harris, Chair
Graduate Research Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

H. Russell Bernard
Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Ronald Cohen
Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William Keegan
Associate Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Edward Malagodi
Professor of Psychology

This dissertation was submitted to the Graduate Faculty of the Department of Anthropology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirement for the degree of Doctor of Philosophy.

August, 1993

Dean of the Graduate School